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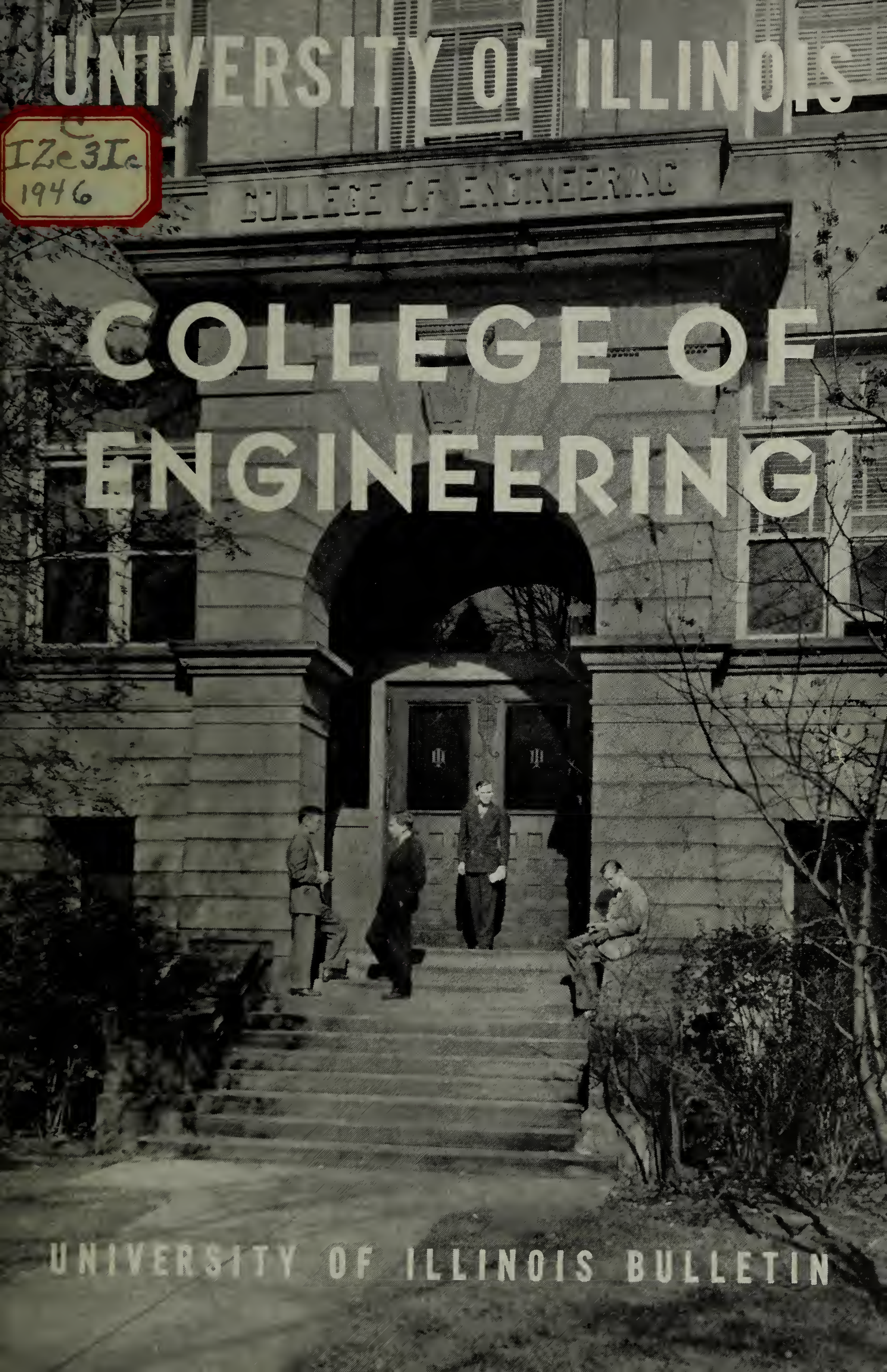
COLLEGE OF ENGINEERING



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UNIVERSITY OF ILLINOIS

ANNOUNCEMENT OF THE COLLEGE OF ENGINEERING

PUBLISHED BY THE UNIVERSITY OF ILLINOIS
URBANA, ILLINOIS
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M. SMITH 23-Je, 47

CONTENTS

PAGE
Board of Trustees and Officers of Administration of the University 4
Staff of the College of Engineering 5
History of the College of Engineering 12
Who Should Study Engineering 14
Purposes and Scope of Instruction 19
Buildings, Libraries, Laboratories, and Equipment 27
Admission 60
Curricula and Degrees in Engineering 65
Courses Offered in the College of Engineering 82
Graduate Work and Research 104
General Information for Students 107
  Student Housing 107
  Illini Union 108
  Annual Expenses 109
  Special Provisions for Veterans 110
  Student Health 110
  Student Employment 111
  Scholarships and Loan Funds 111
  Prizes and Awards 112
  Honors and Honorary Societies 112
  Student Organizations and Activities 112
  Physical Education and Athletics 113
  Military Training 113

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[1] On leave 1945-1946 for war service. [2] On leave 1945-1946 with Small Homes Council.

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[1] On leave 1945-1946 for war service. [2] Inactive service.

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HISTORY OF THE COLLEGE OF ENGINEERING

THE COLLEGE OF ENGINEERING of the University of Illinois, organized in 1870, provided for "courses in Mechanical Science and Art, Civil Engineering, Mining Engineering and Metallurgy, and Architecture and Fine Arts." Definite four-year curricula in Architecture, Civil Engineering, Mechanical Engineering, and Mining Engineering were published in 1871-1872. Instruction in the University, then the Illinois Industrial University, began in March, 1868. The first class, which was graduated in 1872, included six candidates from the College of Engineering — one in Architecture, four in Civil Engineering, and one in Mining Engineering.

The early years of the college were characterized by steady growth, both in the number of students enrolled and in the development of means and methods of effective instruction. From 1885 to 1911, the enrollment in the College of Engineering was more than half that of the men students in the whole University. This steady increase in enrollment reached a peak of 1,297 students in 1909.

Then followed a ten-year period of approximately constant enrollment, ending with a registration of 925 students in 1918-1919, during World War I. From a post-war enrollment of 1,810 students in the fall of 1919, the college moved gradually downward to an enrollment of 1,475 in 1923, and then upward to an all-time high of 1,989 students in 1930. During the summer of 1931, the Department of Architecture was transferred to the newly organized College of Fine and Applied Arts, thereby reducing the enrollment in the College of Engineering by approximately 450 students. World War II had a marked effect on registration in the college; from a 1940 enrollment of more than 1,800, civilian registration declined to 640 in 1943, rising again at the close of the war to a total of 1,851 in March, 1946. However, during this period the College maintained a large over-all registration, through its co-operation with the Navy V-12 training program and the Army's Specialized Training Program.

In 1892, three new curricula were added to the four originally established in 1870, namely, Electrical, Municipal and Sanitary, and Architectural Engineering. Then followed the curricula in Railway Engineering in 1906, Ceramics and Ceramic Engineering in 1915, General Engineering and Engineering Physics in 1920, and Agricultural and Metallurgical Engineering in 1933. The Department of Physics had been established as an independent department in the college in 1890.

The Department of Railway Engineering was dissolved in 1940, and the courses of its three curricula were reorganized and distributed among the departments of Civil, Electrical, and Mechanical Engineering.

In the early stages of its development the college was exceedingly fortunate in the personnel of its departments. Stillman W. Robinson, the first teacher in the new college, was appointed Professor of Mechanical Engineering in December, 1869, and served eight and one-half years in that capacity. He established the first strictly educational shops in the United States. His clear-cut ideas of the aims of engineering education in this country dominated the early development of the college and determined a philosophy of education considered sound in present-day programs. Mathematical theory and scientific research were admirably blended with discussions of engineering practice in Professor Robinson's classroom and laboratory.

Professor Robinson was associated with and followed by a group of pioneers in this almost new type of education. Among them may be mentioned: Professor Selim H. Peabody, in Mechanical Engineering, later elected regent of the University; J. Burkitt Webb and Ira O. Baker, in Civil Engineering; N. Clifford Ricker, in Architecture; Arthur T. Woods and Lester P. Brekenridge, in Mechanical Engineering; Arthur N. Talbot, in Municipal and Sanitary Engineering; Theodore B. Comstock, in Mining Engineering; and Samuel W. Stratton and Albert P. Carman, in Physics. The impress of these pioneers upon engineering education in this country clearly persists to this day in many institutions and in professional practice.

Contrasted with a faculty of 17 professors and assistant professors and the equivalent of 12 instructors and assistants in 1900, the faculty of the College of Engineering and staff of the Engineering Experiment Station in 1946 numbered 147 men of professorial rank, 43 associates and instructors, and 43 assistants, or a total of 233 persons of all ranks.

During World War II, the College of Engineering served notably in training men enrolled in the Navy's V-12 program and the Army's Specialized Training Program. Engineering officers for the Navy, Marine Corps, and Coast Guard, and technicians and specialists needed by the Army were prepared by means of a continuous series of accelerated courses.

The development of the college in a physical sense is illustrated by its growth from a single shop building and classroom space in another structure in 1895, to a well-integrated campus of 17 spacious and modern buildings in 1946, containing classrooms, drafting rooms, laboratories, and adequate supply storage, instrument, and other auxiliary rooms. Included in these quarters is an engineering library of 52,000 volumes, with a subscription list of more than 550 current engineering magazines and periodicals, to serve the needs of students and faculty for standard technical literature and current engineering writing. The value of the equipment in the laboratories and shops, excluding the University Airport, was approximately $1,250,000 in 1945.

The Engineering Experiment Station, the first in any engineering college in the United States, was established in 1903. By 1946, it had published more than 415 bulletins and circulars on important researches in many fields of engineering science and practice. In addition to a sizeable staff devoting their entire time to the work of the Station, all members of the instructional staff of the college are also considered members of the station for purposes of promoting individual and group investigations.

WHO SHOULD STUDY ENGINEERING

WHEN THE HIGH SCHOOL SENIOR is faced with the problem of choosing a life vocation, he finds it difficult to make a decision. Since most boys of high school age have had little or no industrial or commercial experience, they lack the information they need to form a correct judgment of the requirements, both personal and educational, of the numerous vocations. This is particularly true of those vocations which have become professional or semiprofessional in character. The common opinion is that people are *born* to be engineers, doctors, lawyers, or practitioners of other professions. This is true only in a most general sense. One may have good natural abilities and may develop desirable personal characteristics, but he must supplement these traits by long periods of training and hard work to become successful in any professional calling. It is undoubtedly true that any capable boy can learn the theoretical basis of almost any profession and still not be able to acquire the manual and mental skills and techniques of the particular profession he has chosen. What is of even more importance, he may not be able to acquire the career-enthusiasm so essential to success in the practice of the profession. His ability in these respects depends largely on his personal traits, which have been determined to a considerable extent by early training and environment.

Analysis of Profession and Self-Inventory Essential.—The young man should, therefore, take account of the requirements of the profession he is thinking of entering and also make an inventory of his own personal traits and characteristics, to determine, if possible, whether he will be effective and happy in the profession he selects. He must first secure all the information he can about the profession — its physical and intellectual requirements, its exactions, limitations, and rewards. He should make a careful appraisal of his own mental, emotional, and physical endowments on some kind of a personal rating scale, several of which are now available in convenient form. He should next seek the advice of men actively at work in the profession and then the counsel of teachers, parents, and friends. Finally, the balance sheet, as it were, must be struck and a decision made. This decision should not be considered irrevocable. New stimuli and even the forces of chance may serve to change the conclusions first formed. An incidental advantage of such critical self-analysis and vocational appraisal is that they set the individual out from the crowd, stamp him as one with purpose and foresight, and bring to his aid the helpful and sympathetic interest of those competent to give sound vocational advice. However, the final choice must rest wholly with the individual. The courage to accept his own analysis with conviction and trust, coupled with the determination to test the correctness of his conclusions with every ounce of energy and mental acumen he possesses, will quickly bring any young man to a place of vantage from which he may reappraise the items in the balance sheet with exactness and certainty.

Scientific and technical advancements play an important part in every phase of modern life. No one can hope to succeed even moderately in the profession of engineering, where these advancements play the chief part, without first learning what scientific principles there are and how they are applied by the engineer in our complex civilization. Choosing an engineering career, therefore, is in reality determining to study engineering in a standard college or institute. No other satisfactory approach to successful practice in the profession is available. The process of slowly rising through the ranks without such an education is laborious and disheartening, to say the least.

It is the purpose of the following paragraphs to present a few outstanding characteristics of the profession of engineering and a few of the personal qualities demanded of its practitioners.

Preparatory Courses Important.—Since the minimum educational requirement for admission to truly professional engineering work is graduation from an engineering or technical institution, the first important fact to be kept in mind is that a well-balanced but in some respects special preparation in the high school is prerequisite to admission to these institutions (see "Admission," page 60). Any college of engineering in the student's region will be glad to supplement the information from teachers and friends on this point. The few special requirements, particularly in mathematics, should be checked up at the beginning of the senior year in high school. At least three units of mathematics, including solid geometry, are required by all standard schools of engineering.

Analytical Mind Required.—Another fact of importance to be weighed carefully is that engineers must be analytically-minded. By this is meant more than just mathematical expertness, although one should like mathematics and learn it readily if he is to make the greatest success in engineering. The mental characteristic referred to as analytical-mindedness is rather the desire to seek out and determine facts, to arrange facts and events in their logical sequences, and to deduce from them correct and useful conclusions. Everyday manifestations of this trait of mind are sometimes referred to as good judgment and scientific sense. It is generally accompanied by an inborn curiosity about how things operate and are put together. This characteristic, a prime essential in engineering practice, should be given great weight in considering one's qualifications for an engineering career.

Engineering deals with the applications of the physical sciences to industrial and community life, functioning through design, manufacture, construction, maintenance, and operation. Technical achievement must be based on a knowledge of chemistry, physics, mechanics, and mathematics, supplemented by skills in the graphic and manual arts. Esthetic considerations are also of great importance in engineering work, particularly in design and construction. The engineer's structures must be beautiful as well as functional if he wishes to hold the place of prestige in public esteem that the magnitude of his works entitles him to hold. One planning his life work in any branch of engineering should feel a strong interest in and a stimulation from his preparatory work in the sciences and arts. These interests should be given a prominent place on the asset side of the personal rating chart.

Responsibility, Ability to Deal with People Essential.—Engineering is a profession of action. Its practitioners must have both energy and perseverance and must be ready at all times to assume responsibility in whatever direction demanded. Intellectual vigor and honesty are also prime essentials. Sound decisions, based on careful analyses and followed by rapid and skillful execution, are requisites to progress in engineering work. No one should contemplate an engineering career who is unwilling to submit to the mental rigors and disciplines that these requirements impose.

Again, those who practice the profession of engineering are constantly brought into direct and intimate contact with problems of a social, or human, character. This has always been true to a greater or less degree, but in our present-day complex life it is imperative that those in charge of private and public enterprises rely to the fullest extent upon the knowledge, judgment, and experience of the engineer, both in determining what should be done and how to do it. The engineer, in turn, must know the needs and desires of society. He must employ many men in carrying out designs and plans that have been made and, therefore, he must know how to handle men and their community problems. He must appear before boards and commissions and discuss intelligently and convincingly the economic and social effects of proposed engineering work. No longer is it possible for him to confine his sphere of activities to "the use of the materials and forces of nature for the benefit of mankind." Human forces must be included in his planning.

Because of these changed conditions, trained engineers are being sought out more and more and placed in positions of trust and responsibility quite outside those of a strictly technical nature, where economic, educational, and social questions are the predominating ones. All this suggests the fact that a young man who contemplates entering the engineering profession should possess and be anxious to develop those qualities of mind and personality that will make him effective in these broad spheres of activity as well as in the technical phases of his work.

Best Technical Training Needed.—It goes without saying that the truly professional engineer must be a technically trained man in the real sense of the word. His primary field of activity embraces all the materials and forces of nature. To make them serve the manifold needs and pleasures of mankind is his job. This means intense technical training and a long period of engineering apprenticeship to gain practical experience. In spite of these facts, engineering is not a closed profession as are the medical and legal professions. There are many grades of responsibility through which an engineer must pass in reaching the position of chief engineer, any one of which may be considered an end in itself. There are also many well-defined subprofessional classifications for those who prefer the narrower fields of activity, such as surveyors, draftsmen, foremen, superintendents, technicians, and others. Sub-professional experience is also a stage or stepping-stone for those seeking the highest professional status. An engineering education is a profitable investment even if considered only as a preparation for sub-professional work.

Finally, the young man beginning the study of engineering should understand the differences between the profession of engineering and the various crafts and trades allied and supplementary to it. He should not mistake the work of the machinist, the electrician, and the skilled artisan in other crafts for the scientific and professional work in engineering. One interested only in a career of craftsmanship should not ordinarily plan to study in an engineering college. He will find the various mechanics institutes better suited to his needs at much less cost. This is not to say that engineering is something quite apart from the skilled trades and crafts. Every engineer should be an artisan in his own right, but the training required in each classification is greatly different.

Financial Rewards Vary.—Financial rewards in engineering practice vary as a matter of course with the different degrees of professional status attained. Against the cost of an engineering education one may set a scale of remuneration beginning on the average at $175 to $225 a month at graduation and increasing steadily to the higher brackets of $7,000 to $20,000 a year for those who are successful in practice and are put in charge of large engineering organizations and enterprises.

The question — "Who should study engineering?" — cannot be answered by any simple formula or phrase. The range of engineering activities is so great that many men of widely differing abilities and training find opportunity for useful and satisfying work within the boundaries of professional practice. A still greater number of persons are employed in vocations closely connected to professional engineering and absolutely necessary to its existence. For all of these callings an engineering education is fast becoming an indispensable requirement. Consequently, schools of engineering all over the country offer various programs of study, called curricula, which combine the basic scientific and mathematical principles underlying the practice of engineering with economic, social, and cultural studies into a closely integrated and coordinated whole. This has proved a highly successful type of education, even as a preparation for many vocations in this industrial age not included within the sphere of engineering activity.

Literature on the Profession of Engineering.—The foregoing paragraphs have indicated some of the guideposts for the young man contemplating an engineering career. Other suggestions should be sought from published writings of competent men. There is a dearth of literature specifically about engineers and the profession of engineering. On the other hand, a great deal is written about engineering work and the manner of its accomplishment in more than 500 technical magazines and journals. Many of these publications can be found in the general city libraries. A young man contemplating a career in engineering should make it a point to read as much as he can in these magazines. The following list contains some of the more valuable and interesting books suitable to the purpose of vocational guidance. It is hoped that most of them are available in every high school library.

The Profession of Engineering, by D. C. Jackson & W. P. Jones, 1929. John Wiley & Sons, New York.

The Engineer — His Work and His Education, by R. L. Sackett, 1928. Ginn & Company, Boston, Massachusetts.

Engineering as a Career, by the Engineers' Council for Professional Development, 1939. 29 West 39th Street, New York.

Vocational Guidance in Engineering Lines, by the American Association of Engineers, 1933. The Mack Printing Company, Easton, Pennsylvania.

Building an Engineering Career, by C. C. Williams, 1934. McGraw-Hill Book Company, New York.

The Young Man and Civil Engineering, by George F. Swain, 1922. Macmilian Company, 60 Fifth Avenue, New York.

How to Study, by George F. Swain, 1917. McGraw-Hill Book Company, New York.

How to Study Effectively, by G. M. Whipple, 1916. Public-School Publishing Company, Bloomington, Illinois.

Careers (a series of pamphlets), by the Institute for Research, 537 South Dearborn Street, Chicago. 1936 to date.

Careers in the Mineral Industries, by Thomas T. Read, 1939. Published by the American Institute of Mining and Metallurgical Engineers through the Seeley W. Mudd Memorial Fund, 29 West 39th Street, New York.

PURPOSES AND SCOPE OF INSTRUCTION

THE CURRICULA OF STUDY in the College of Engineering, as well as the individual classroom and laboratory instruction, are based on the well-known fact that successful professional practice in engineering depends primarily on a thorough knowledge of the principles of the mathematical and physical sciences and of their applications in the design, construction, and operation of engineering and industrial works. For this reason, the curricula of the college, outlined in later pages, are fundamentally scientific in character for the first three years, with a common core of subject matter in the first two years. Sufficient practice in the application of principles in design and operation is required in the fourth year to make the student's knowledge applicable to his later engineering work. A moderate amount of specialization is provided through options, or special arrangements of courses, in the senior year. It is held that real specialization must be built on a thorough groundwork of fundamental training in science, and is best carried on through graduate study, for which abundant opportunity is provided by the University. A carefully arranged five-year program of undergraduate study also permits specialization and at the same time provides opportunity for broadening the student's viewpoints in fields allied to his specialty.

The necessary skills and techniques of manipulation and graphical expression are taught in intensive courses early in the curricula. A thorough command of written and oral English is considered essential in the engineer's training, and substantial work in this field is required. The social, economic, and esthetic implications of the engineer's work are presented to the student through the regular classroom instruction and by means of formal non-technical courses in the College of Engineering and in other departments of the University.

Correct professional attitudes are acquired by young men through close personal association with members of the faculty of broad engineering experience; through studies of codes of professional ethics, addresses, and biographies of engineers; and through employment on engineering work under men of character and high professional ideals. The student's personality and qualities of leadership as well as his interest in, and understanding of, human behavior under varying conditions — factors of great importance in engineering practice — are developed through extracurricular activities of many sorts. Typical of the college and university organizations sponsoring these activities under faculty guidance may be cited the student chapters of the national engineering societies, university musical and dramatic clubs, intramural and collegiate debating teams, college and university publications, the Reserve Officers' Training Corps, intramural and intercollegiate athletics, literary societies, fraternities, and other social organizations.

The trained and experienced engineer is peculiarly fitted to assume leadership in business activities having to do with manufacturing, transportation, communication, and construction. He must attain his place of pre-eminence in these fields by a mastery of their technology through actual experience. It is recognized, however, that certain fundamentals of management and administration can be learned in a college classroom. The curriculum in General Engineering furnishes an opportunity in this direction, as well as in other fields not covered by the classifications of the older curricula.

The place of the engineer in the public service has always been recognized as an important one. In recent years, the employment of his services in this direction has greatly increased. The College of Engineering has provided postgraduate one-year programs of study for persons holding bachelor's degrees in engineering who wish to prepare themselves definitely for the public service. A certain part of the program can be accomplished for credit in the undergraduate curriculum. The College of Engineering maintains outlines of courses suited to various circumstances of preparation, supplementing the publication entitled *University Training for the Public Service.*

The college administers its curricula and carries out its functions of instruction and research through the medium of nine separate but well-coordinated departments, seven of which offer curricula leading to the degree of Bachelor of Science, with designation of the course pursued. Two curricula are administered directly by the dean of the college, namely, Agricultural Engineering and General Engineering, the first in close cooperation with the College of Agriculture, the second as an independent curriculum with somewhat less emphasis on technical design than the standard curricula impose. The curriculum in Chemical Engineering is administered by the College of Liberal Arts and Sciences. A brief statement of the specific purposes and scope of the curricula and work done in each of these departments follows.

Students of high scholastic achievement, with exceptional aptitudes and interests in special fields of engineering science and application, may be permitted to vary the course content of the standard curriculum of the department in which they are registered, with the purpose of emphasizing some phases of the general area of knowledge which are not included in the standard curriculum or which cannot be encompassed by the usual procedure of course substitution and selection of electives. These unwritten curricula, however, include all of the fundamental underlying courses of the standard curricula, the variations being made mainly in the so-called "application" portions of the standard curricula of the college. The program of studies of each student permitted to take such a dual curriculum must be approved by a committee of the college, of which the associate dean is chairman, in consultation with the head of the department in which the student is registered and with a professor of the college offering courses in the field which the student intends to emphasize.

Aeronautical Engineering.—The curriculum in Aeronautical Engineering is offered primarily to train students in the fundamental principles of airframe and aircraft power plant design and construction. The courses included in the required portion of the curriculum are intended to prepare students for any of the several technical divisions of the aircraft industry, and to provide sound training in engineering fundamentals which can be applied to practice in allied engineering fields. Provisions for elective courses enable the student to select courses of study in the fields of airplane design, aircraft power plant design, aircraft production and maintenance engineering, and airline engineering. A high degree of specialization is not encouraged in the undergraduate program but graduate study and research may be pursued in aerodynamics, aircraft structures, and specialized phases of the divisions previously listed.

The present rapid development of the aeronautical industry provides a variety of opportunities for graduates in this field. To prepare students to take advantage of these opportunities, every effort is made to offer courses providing the fundamental instruction necessary for an understanding of the engineering principles upon which these advances are being made. Instruction in the fields of supersonic aerodynamics and reaction type engines is being expanded and new courses will be added in all divisions of aeronautical engineering as they are needed.

Agricultural Engineering.—The curriculum in Agricultural Engineering is provided for students who plan to enter teaching, research, or commercial and industrial work in this field. The scope covered can be visualized under four main headings: (1) Power and machinery, including consideration of the types available and applicable to farm operation; the design of implements, machines, vehicles, and other equipment; and the development and use of various suitable materials of construction. (2) Farm electrification, including electrical service to rural areas, and the development and use of the electrical farm machinery and equipment involved in the extensive utilization of electricity in agriculture. (3) Farm buildings and housing, including design, location, and arrangement; functional requirements, lighting, heating, and ventilating of farm buildings; and the provisions for refrigeration equipment, water supplies, and sewage disposal. (4) Soil and water conservation, including drainage, soil erosion control, flood control, land clearing, irrigation, and other physical improvements.

The agricultural engineering curriculum is fundamentally an engineering program, with moderate specialization beginning in the second year. The curriculum printed on pages 68 and 69 provides for an option in power and machinery and an option in structures and soil conservation. It is possible by this plan to provide thorough training in fundamental sciences and engineering design, and yet there is opportunity for some specialization in the principal fields of agricultural engineering.

The Agricultural Engineering Department, administered by the College of Agriculture and allied with the College of Engineering, is a unit in the

Agricultural Experiment Station and the Agricultural Extension Service. Thus the student has the advantage of close contact with the staffs and facilities of both colleges. The curriculum is administered by the College of Engineering and the degrees are awarded upon certification by its faculty.

Ceramic Engineering.—The curriculum in Ceramic Engineering leading to the Bachelor of Science degree in Ceramic Engineering, is designed to prepare the student to enter any of the ceramic industries — glass manufacture, porcelain enamels, structural clay products, refractories, whitewares, pottery, abrasives, and cements. The first-year courses, similar to those in other engineering curricula, provide sound basic training in science and engineering; a general introduction to ceramics is offered in the sophomore year, fundamentals of ceramic engineering in the junior year, and specialization and practical applications in the senior year.

By the proper selection of courses, the student may specialize for either production or research in the different branches of the ceramic industry. The required courses include preparation for the designing of plants and equipment, the construction of kilns and dryers, and the supervision of manufacturing operations. Graduate courses are given leading to the Master of Science and Doctor of Philosophy degrees in Ceramic Engineering and in Ceramics. The degrees in Ceramics are granted to men not having a B.S. degree in Engineering. Advanced work is available in each of the different branches of Ceramics.

Chemical Engineering.—The curriculum in Chemical Engineering is administered by the College of Liberal Arts and Sciences. It is designed to train students to develop, design, and operate new processes, to improve existing processes, and to supervise manufacturing plants in the chemical industry. A broad training in the fundamentals of chemistry and physics and the application of mathematics to these sciences is required before the actual courses in Chemical Engineering are started. The laboratory and classroom work includes many practical problems requiring technical knowledge and economic judgment. The curriculum leads to the degree of Bachelor of Science in Chemical Engineering. Postgraduate work in various fields is also offered, leading to the degrees of Master of Science and Doctor of Philosophy in Chemical Engineering.

Civil Engineering.—The curriculum in Civil Engineering offers a systematic training in the principles and procedures involved in professional practice in the various phases of this field. Emphasis is placed on basic principles and design procedures rather than on routine computations, or on techniques and information which are readily obtained in engineering offices or on construction work after graduation. Courses are included dealing with the design and construction of bridges, buildings, dams, retaining walls, foundations, aircraft structures and airports; the design, construction, and operation of water supply and sewage disposal systems, highways, and railways; methods and engineering works involved in flood control and drainage; and the preparation of cost estimates, contracts and specifications. Opportunities are offered in the senior year for a certain amount of specialization in the more important branches of civil engineering through options in structures, including aircraft structures; transportation by highway, railway, and airway; and hydraulic engineering. A general option is offered to make possible the election of courses to suit other special interests a student may have. The curriculum in Sanitary Engineering, described on page 81, is administered by the Department of Civil Engineering. The curriculum in Public Health Engineering, described on page 81, is offered in the College of Engineering and in the College of Medicine.

A summer surveying camp is provided for field instruction in surveying between the freshman and sophomore years, and an arrangement is in effect with the Illinois State Highway Department under which students may obtain engineering experience, with pay, during the subsequent two summers in college.

Electrical Engineering.—The curriculum in Electrical Engineering offers a training in the principles of generation, transmission, distribution, and utilization of electrical energy, and a working knowledge of the equipment required in each of these fields. After basic courses in mathematical principles and physical sciences, the work in electrical engineering is introduced in the second year by a course in principles of illuminating engineering and electrical distribution in buildings. In the third year courses are offered in circuit analysis, electronics, and the theory of direct current apparatus. Laboratory work, emphasizing the principles being studied, accompanies each course. In the fourth year a student may choose between the power and the communication fields of study. Technical courses are offered concerning electrical machinery, power systems, illumination, industrial electronic applications and communication at all frequencies, including the ultra-high range. Investigations of problems in power distribution and control of communications problems are made in advanced laboratory work. All laboratories are exceptionally well equipped.

General Engineering.—This curriculum provides a fundamental engineering training with moderate emphasis on design and a fixed requirement of fifteen credit hours in economics, corporations, finance, engineering law, and labor problems. Specialization in any field of the student's choice is permitted in the liberal provisions for elective studies, as well as an option by means of which he may elect either structural or machine design. The curriculum is intended for those who do not care to follow the more technical phases of engineering practice but who desire to ally themselves with industrial and commercial development in the fields of management, operation, and construction — preparation for which is founded on scientific and engineering facts and disciplines, supplemented by economic and social orientations.

General Engineering Drawing.—The courses in this department are intended to develop the theory, skill, and technique needed for the preparation and understanding of engineering plans and designs by means of the graphical language. Both orthographic and pictorial forms of representation are covered in elementary and advanced courses. The work in descriptive geometry is well coordinated with the drawing courses and with practical problems in engineering. The constant use of methods of exact geometrical analysis necessarily employed in this subject, combined with the steady development of the student's powers of reasoning and visualization, furnishes him a background of great value in his later study of engineering problems.

Mechanical Engineering.—The courses in Mechanical Engineering are planned to present the theory and practice of the generation and transmission of power, and of the design, construction, operation, and testing of machinery of all kinds. In the laboratories, emphasis is given to the engineering and economic principles of machine operation, performance, and construction, and to problems of scientific shop management. Through a wide choice of electives, there is opportunity for an introduction to such subjects as economics, political science, industrial organization, and business management. Options in the senior year give the student an opportunity to follow his interest in one of several fields, such as heat engineering, refrigeration engineering, mechanical design, heating, ventilating, and air conditioning. Options in petroleum production engineering and railway mechanical engineering are also provided.

Mining and Metallurgical Engineering.—The Department of Mining and Metallurgical Engineering offers two curricula, as follows:

Mining Engineering. — The curriculum in Mining Engineering is designed for instruction in the fundamental engineering problems dealing with the extraction of coal and minerals from the earth, and the preliminary preparation of these substances for use in our modern-day civilization. To the preliminary courses in mathematics, physics, chemistry, general engineering drawing, and mechanics, common to all engineering curricula, the department adds specialized courses in mine surveying, mining methods, prospecting, mine examination, mine ventilation, coal preparation, mineral dressing, mine administration, and design of mine plants. Interwoven with the departmental program is a series of required courses which provides a broad engineering background. The inclusion of elective courses in the curriculum offers flexibility in caring for the needs of the individual students.

Metallurgical Engineering. — Metallurgy may be divided into three main divisions — chemical, mechanical, and physical. Chemical metallurgy includes the metallurgical processes involving chemical change and embraces methods of production and refining of metals from their ores. Mechanical metallurgy includes all the processes of working and shaping metals and alloys — processes which do not involve chemical changes but adapt metals as to size and form, such as rolling, forging, drawing, spinning, casting, etc. Physical metallurgy deals with the nature, structure, and physical and mechanical properties of metals and alloys. It includes metallography, testing of metals and alloys, heat treatment of metals and alloys and the physical changes produced thereby.

The curriculum in metallurgical engineering has been designed to include the engineering fundamentals of these three main divisions, but emphasis is placed upon physical metallurgy. Specialized courses are provided for ferrous and non-ferrous process metallurgy, metallurgy of deep drawing and pressing, physical metallurgy, ferrous and non-ferrous metallography, physics of metals, electrometallurgy, heat treatment, fuels and furnaces, and alloy steels.

Physics.—The Physics Department offers the course in general physics which is a part of the basic training of all engineering students. In addition, it offers a curriculum in Engineering Physics, designed to give students the broad and thorough training in fundamental physics and mathematics which is demanded by the increasing complexity of engineering research, development and application. The work of the first two years is much like that in the other engineering curricula; in the last two years advanced courses in physics, mathematics, and chemistry are emphasized, but there is a liberal allowance of time for the study of any field of engineering in which the student is especially interested. The details of technical applications are left to be learned in connection with a particular job; or if the electives are properly selected, the curriculum may be made a basis for graduate work in some particular field of engineering or in physics. The department is well provided with the equipment and facilities for carrying on research in numerous fields of modern physics.

Public Health Engineering.—The curriculum in Public Health Engineering is offered in the College of Engineering and in the College of Medicine, as shown on page 81. The purpose of the curriculum is to train engineers needed in public health agencies.

Sanitary Engineering.—The curriculum in Sanitary Engineering parallels closely that in civil engineering, putting greater emphasis on the engineering problems involved in the control of the environment to protect and to improve health and comfort. The curriculum, which is administered by the Department of Civil Engineering, leads to the degree of Bachelor of Science in Sanitary Engineering. The laboratory facilities, administered by the Civil Engineering Department, are described under Civil Engineering on page 38.

Theoretical and Applied Mechanics.—Courses in Theoretical and Applied Mechanics are required in all the engineering curricula. The purpose of the courses is to teach the student to analyze and solve engineering problems by applying the principles of mathematics and of mechanics to conditions as they arise in the design, construction, and operation of engineering structures and machines. In the well-equipped laboratories the student tests many engineering materials, such as steel, brass, aluminum, timber, and concrete, to determine the various properties needed in the use of the materials in design and construction, and in the writing of specifications for the materials.

All of the recent important tests are performed, with special emphasis upon the significance of the properties of materials in the light of their use in modern engineering practice which involves high speeds and extremes of high and low temperatures. In the hydraulics and fluid mechanics laboratory the student performs experiments on the flow of water in pipes and open channels and on the flow of oil in pipes. He studies the viscosity of various fluids and determines the operating characteristics of different kinds of pumps and turbines. A number of advanced courses in the analysis of stresses in materials, in testing of materials, and in hydraulics and fluid mechanics, are offered, which may be elected by junior, senior and graduate students.

A large amount of research work is carried out in the laboratories, some of which involves tests of large members. A 3,000,000-pound testing machine is available for this work. Students are encouraged to follow the progress of this investigational work.

BUILDINGS, LIBRARIES, LABORATORIES, AND EQUIPMENT

THE BUILDINGS OF THE COLLEGE OF ENGINEERING form a compact group on the north campus of the University. In these buildings are located the classrooms, laboratories, and drafting rooms most used by students enrolled in the engineering curricula. Immediately to the south, in buildings on the middle campus, are the classrooms and laboratories of the College of Liberal Arts and Sciences, so much frequented by engineering students in their first two years of work. The close daily contact of students of all four classes in the College of Engineering, from the freshman year through the senior year, develops their common interests and a spirit of college unity and professional morale. Their interests are broadened, at the same time, through contact with students in other colleges of the University, in classrooms on other parts of the campus.

The Engineering Library

The Engineering Library, which occupies the first and second floors of the north wing of Engineering Hall, contains 52,000 volumes, including books, bound volumes of magazines, and publications of engineering societies. It has also a large number of pamphlets, lantern slides, and manufacturers' catalogs, including "Catalog Studies." More than 550 technical magazines and publications of engineering societies are currently received.

The library has a good collection of biographies of engineers and of early books on engineering. Its collections of early books on mechanics and strength of materials, on railways and on the telephone and telegraph, are considered to be among the best in the country. It has a limited number of books for general reading, including a collection of "Engineering Fiction," of popular books in science and of books on vocational guidance along engineering lines, as well as all of the books on the "Reading List for Junior Engineers" prepared by the Engineers' Council for Professional Development. The library also includes an excellent collection of general technical dictionaries in the several foreign languages with definitions in English, as well as similar dictionaries in special fields of engineering. It has most of the engineering publications of state, federal, and foreign governments. Each year, important books and sets on engineering in foreign languages, as well as in the English language, are added.

The Ockerson Collection of books on River Improvement, which was a part of the private library of the late John A. Ockerson of the Class of 1873, was presented to the University of Illinois by Mrs. Ockerson in 1924, and is housed in the Engineering Library.

The main Engineering Library is supplemented by several departmental libraries of a scientific and engineering nature. Notable among these are the libraries in Ceramics and Ceramic Engineering, Chemistry, Physics, and Mathematics. In addition, much engineering material is housed in the General University Library which contains over two million volumes.

View of the College of Engineering Library, Which Contains 52,000 Volumes and Receives More Than 550 Technical Periodicals

To aid users in reference and research work, the Engineering Library has complete sets of important indexes to periodical literature, such as the Engineering Index and the Industrial Arts Index, as well as indexes to individual sets of engineering magazines, publications of engineering societies and other series. It has also complete sets of the more important abstracts, such as Chemical Abstracts and Science Abstracts, as well as abstracts covering the literature of many of the divisions and sub-divisions of the fields of engineering. Many other bibliographical aids are also to be found in the library.

The Engineering Library has two well-equipped reading rooms and provides a number of individual study tables for faculty and for graduate students.

Laboratories

The laboratories of the College of Engineering are numerous and well equipped. The laboratories used in research are not entirely separated from those used in the instructional work. Thus the student is brought into desirable contact with this important part of the college program while he is still doing his undergraduate work. In many instances temporary laboratories are set up for special research projects, and laboratories in other parts of the country are used in some investigations.

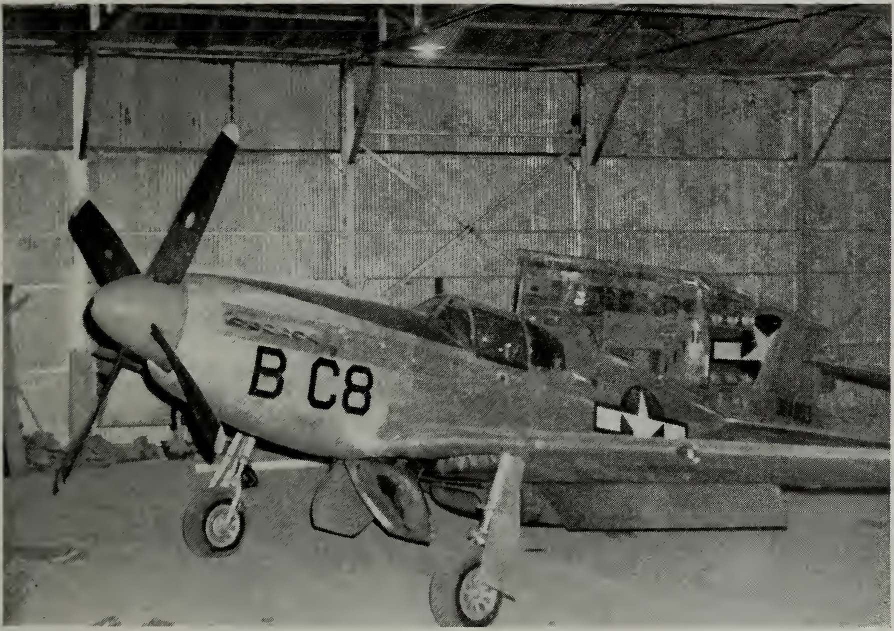
New laboratory equipment is continually acquired in line with new developments in engineering theory and technique. Thus recent years have been marked by the acquisition of the latest equipment available in the fields of aeronautics, nuclear physics and radar, as well as recently developed equipment needed for thorough study and research work in the long-established branches of engineering.

The following descriptions of the laboratories and equipment of the college, arranged in the alphabetical order of departments, are intended to furnish the reader with sufficient information on which to base a judgment of the adequacy of the physical facilities for both instruction and research. Additional details will be supplied by the dean of the college or by the head of any department on request.

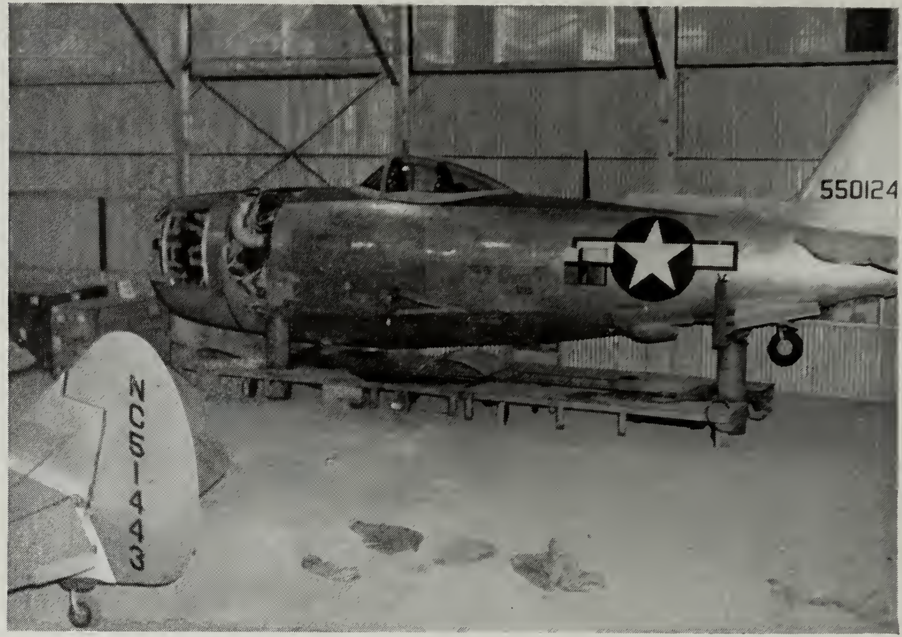
Aeronautical Engineering Laboratories and Equipment

The laboratory facilities of the Department of Aeronautical Engineering are located on the University campus and at the University of Illinois Airport. Extensive plans are being made to develop the most modern types of instructional and research laboratories.

University of Illinois Airport.—The University of Illinois Airport, with three concrete runways, each 5,300 feet long and 150 feet wide, one turf runway 4,000 feet long and 150 feet wide, and 12,000 feet of concrete taxiway 50 feet wide, provides one of the most modern university laboratories of



One of the Department of Aeronautical Engineering's Airplanes — North American P-51



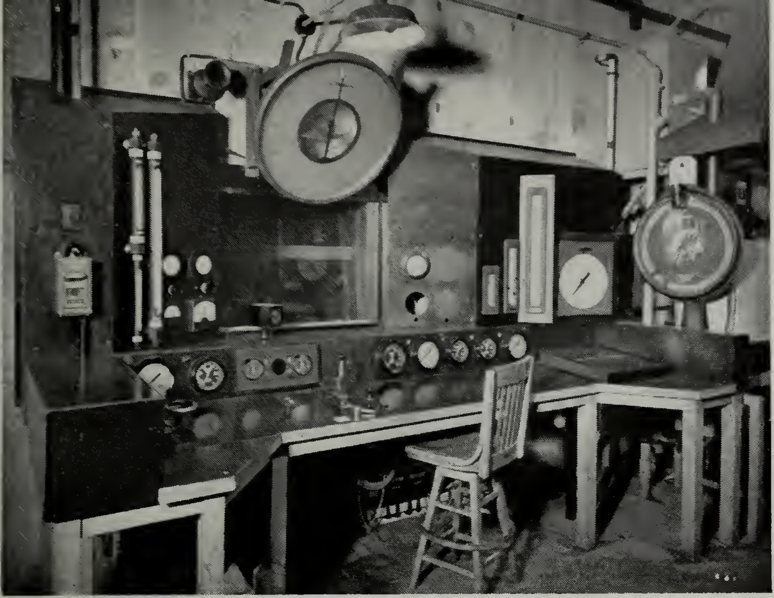
Another Departmental Airplane — Republic P-47N

this type in the country. Contemplated construction at the airport includes buildings for education and research, airport administration, and hangars for storage and maintenance of private, commercial, and military flight equipment.

In addition to the facilities for technical work in aeronautical engineering, the airport provides an excellent laboratory for education and research in many fields connected with air transportation. Private, government-sponsored civilian, and military flight training programs may be conducted at the airport, thus making it possible for students in any division of the University to receive this type of instruction if they so desire. Commercial activities at the airport will give students an opportunity to secure additional practical information in airline engineering.

Aerodynamics Laboratory.—The undergraduate aerodynamics laboratory is located on the campus. A wind-tunnel having a test section 48 inches by 30 inches, used for the teaching of wind-tunnel techniques, will provide students with both qualitative and quantitative data for verifying the aerodynamic theory learned in the classroom. Various apparatus for visual flow demonstration will be provided.

Aircraft Power Plants Laboratory.—This laboratory, located at the airport, offers facilities permitting tests of aircraft reciprocating engines, various types of reaction engines such as jet propulsion units, engine instal-



Engine Test Control Room

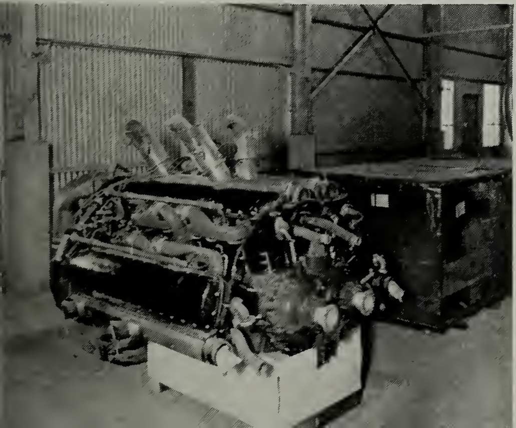
lations, and fuels and lubricants. A burner laboratory will provide facilities for fundamental combustion studies. Equipment for testing and studying design features of aircraft engine accessories will be included.

Aircraft Laboratory.—This laboratory, also located at the airport, provides facilities for the study and testing of airframes. Static and dynamic physical tests of aircraft assemblies, or complete aircraft, may be made here. Mock-ups and sections of complete aircraft and parts illustrate the design and function of various power plant and airframe structures, hydraulic systems, electric systems, and mechanical devices.

Agricultural Engineering Laboratories and Equipment

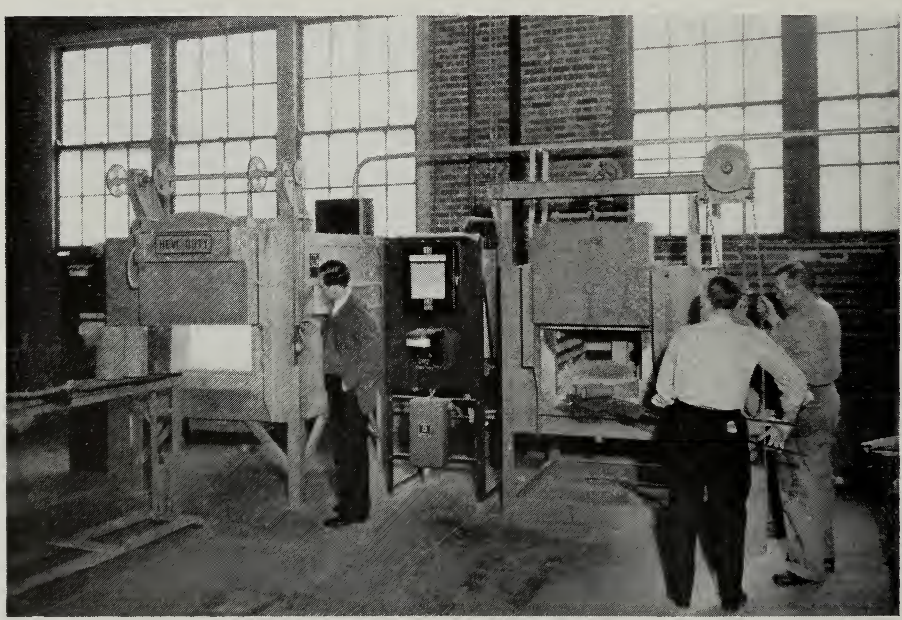
The laboratories of the Department of Agricultural Engineering include space and facilities for the study of farm machinery, internal combustion engines, tractors, and home utilities; a drafting room; and special laboratories for research.

Allison 3420 Aircraft Engine — 2,600 h.p.



Contra-rotating Propellers and Gear Box for Model XP-75 Airplane

Kiln Laboratory — Some of the Kilns and Furnaces for Firing Ceramic Bodies and Glazes



Electric Furnaces — Firing Porcelain Enamels

The machinery laboratory has various types of farm machines and implements and horticultural and dairy machinery. The tractor laboratory provides an assortment of engines and tractors, dynamometers for determining horsepower of tractors and requirements of power-driven machines, a motor generator set for outside test work, an oil testing laboratory, shops, and other facilities for the study of power units. The home equipment laboratory contains various types of electrically operated farm and home equipment and appliances.

An air-conditioned room, equipped with test apparatus, is used for studying problems of seed cleaning and grading. Another laboratory is provided with dehydration equipment for determining optimum conditions of humidity and temperatures for storage or processing.

Ceramic Engineering Laboratories and Equipment

The laboratory facilities of the Department of Ceramic Engineering include the following: the general ceramic laboratories; separate laboratories for pottery, enamels, structural clay products, microscopy, and drying; a kiln laboratory; research laboratories; a museum; and a library.

Ceramic Laboratories.—The laboratory courses in raw materials, bodies glazes, and enamels are conducted on the first floor of the Ceramics Building, where facilities are provided for 60 students. These laboratories contain all the apparatus and equipment usually required for the grinding and the pulverizing of materials for the study of physical properties, and for testing pottery, glasses, glazes, and enamels.

Pottery Laboratory.—The pottery laboratory is used for instruction in the preparation of body mixtures, for demonstration and practice in the various methods of pottery production, and for the making of special articles used for class and research work. The slip house and molding equipment are very complete. The shop for demonstrating the making of plaster molds, for jiggering, casting, or pressing wares, contains jollys, layout tables, whirlers, and lathe.

Kiln Laboratory.—This laboratory, 100 x 42 feet in size, houses the semi-plant and plant sized equipment, kilns and furnaces. The eight oil and gas fired kilns range in size from five cubic feet to 50 cubic feet capacity and provide temperatures up to 3000° F. Two 60-pound batch rotary enamel smelters, eight pot-type furnaces and cone-fusion furnaces, supplementing the larger ones, are used for special purposes or higher temperatures. Three electric furnaces, with hearths ranging up to about 2 x 2 x 3½ feet inside, are used for special firing. All furnaces and kilns are wired for thermocouples to a control room where automatic pyrometric equipment is located.

Enamel Laboratory.—This laboratory, designed for instruction and research in all branches of vitreous enameling, is equipped completely for the chemical cleaning and pickling of sheet iron and the sandblasting of cast

Pottery Laboratory — Forming Ceramic Products by Jiggering and Casting in Plastic Molds

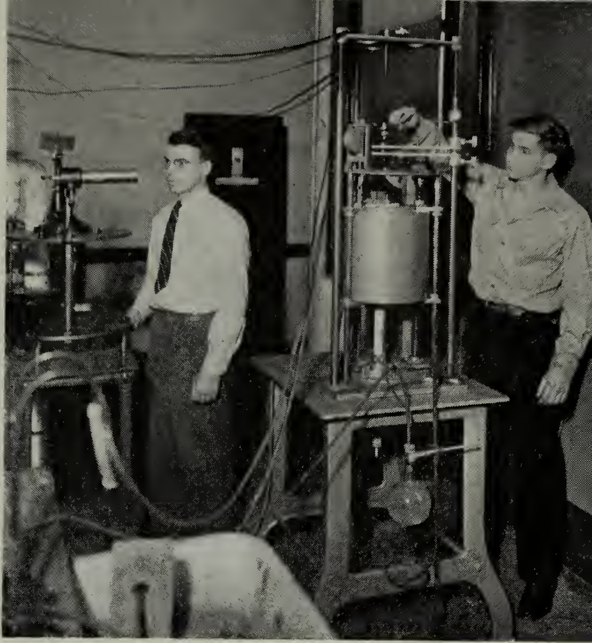
iron. Furnaces for the smelting of all types of enamel are available, including nine gas-fired crucible pot furnaces, two high-temperature electric pot furnaces, one tank-type gas-fired furnace, and two rotary furnaces of the ordinary commercial type. The equipment for dipping and spraying is modern and extensive.

The enamels are fired in six electric furnaces, five of the chromel resistance type and one containing a special high temperature alloy, all controlled by automatic recording control pyrometers. The furnaces cover a wide range of sizes, the largest having a chamber 24 x 24 x 40 inches. The testing equipment includes a Hunter Multipurpose Reflectometer and a Photovolt Reflectometer, the G. E. Thickness Gauge and the Magna Gauge, the Bureau of Standards Gauge machine and impact equipment, binocular and ultrapac microscopes, and other miscellaneous apparatus. A recording Spectrophotometer, a spectroscope and complete X-ray equipment are also available.

Structural Clay Products Laboratory.—A part of the floor space in the kiln laboratory is utilized for machinery equipment. There is installed a

Ceramic Materials Laboratory — Examination and Testing of Raw Materials, Bodies, and Glazes

brick-making unit with pug mill, auger machine, and hand-operated cutter. A smaller auger machine for making tiles and bars, a small de-airing unit, a Simpson mixer, a 7 x 10-inch jaw crusher, five-foot dry and wet pans, a vibrating screen, a hand-power saggar press, a hand-power repress, a 50,000-pound capacity hydraulic press, smaller plunger presses, and a dryer complete the equipment of this laboratory.



Student Research — Measuring the Viscosity of Glass

Drying Laboratory. — Experiments on the drying of clay products and studies of the fundamental principles involved in drying are conducted in a drying cabinet with forced air circulation and automatic control of temperature and relative humidity.

Microscopy Laboratory.—The petrographic microscope equipment includes instruments with complete accessories for research and others for student instruction, three binocular microscopes, dark field parabaloid condenser, cardioid condenser, camera for taking photomicrographs with lens attachments for macrophotography, and thin-section cutting apparatus. There is a large collection of minerals, ceramic raw materials, ceramic wares including refractories illustrating the effects of service in glass melting and other furnace operations, and specimens of faults found in defective glass. The equipment is sufficiently extensive and so chosen as to permit the study of particles of all sizes falling within the whole range of optical visibility.

Research Laboratories.—Research is an important function of the department, and excellent equipment is provided for this type of work in several laboratories separate and distinct from all others. For investigations which must be conducted at high temperatures, a variety of furnaces capable of close temperature regulation, and some with atmospheric control, are available. In addition to the above equipment, there are available a super centrifuge, a colloid mill, and Fizeau-Pulfrich interferometers.

Museum.—Most of the departmental museum specimens exemplify engineering phases of ceramics. In addition, a collection of about two hundred objects affording a view of the scope of ceramic art has been acquired through purchase and gifts. These include representative pieces from American and foreign potteries.

Ceramics Library.—There is a departmental library of about 2,500 volumes, restricted to ceramics and the parts of physical and chemical sciences which are important in its study. Additional sources of ceramic information are present in the 36 periodicals and journals for which the department subscribes.

Civil and Sanitary Engineering Laboratories and Equipment

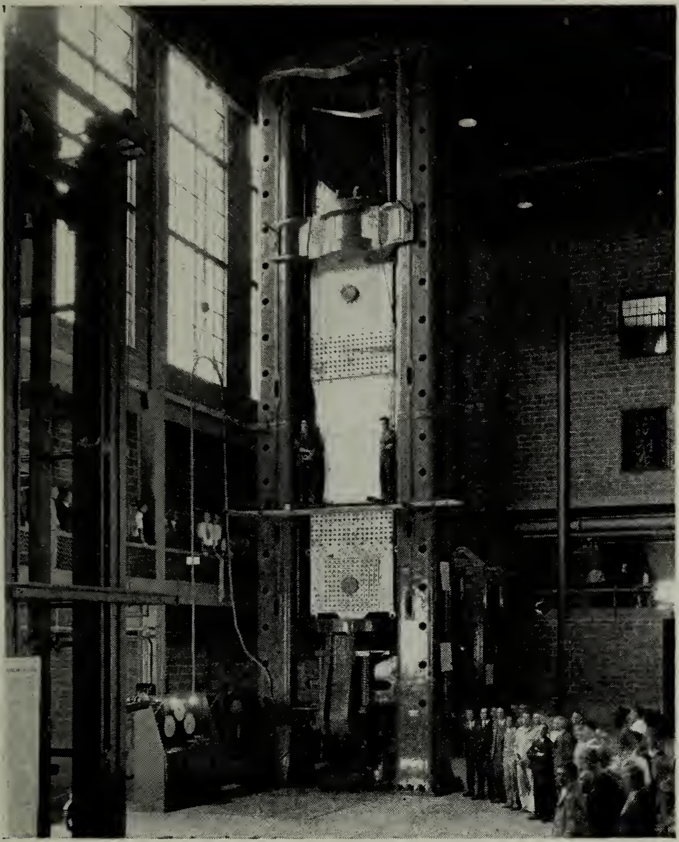
The structural research, cement and concrete, soil mechanics, bituminous materials, non-bituminous, and soil mechanics laboratories of the Department of Civil Engineering are located in Talbot Laboratory. This is the outstanding building of its kind in the country. Its floor area of 82,000 square feet is shared with the Department of Theoretical and Applied Mechanics. The Sanitary Engineering Laboratory and the Surveying Laboratory occupy separate buildings. The Hydraulic Engineering Laboratory, in the State Water Survey Building, for which funds were appropriated in 1945, is to be available to civil engineering students. The summer surveying camp is leased from the U.S. Forest Service. Brief descriptions of these laboratories follow.

Structural Research Laboratory.—The structural research laboratory has been designed and equipped for testing and research on large structural members and whole structures in steel or concrete, as distinguished from investigations of the physical properties of materials. Much of the equipment is of special design, being built for tests of particular members or structures. Some outstanding installations of this type are: the equipment used in the tests of multiple-span reinforced concrete arch bridges having an over-all length of about 100 feet and a height of 35 feet; two 200,000-pound fatigue testing machines for subjecting joints in structural members to repeated and reversed loads; and tension machines for subjecting structural members to high-speed loading.

The main laboratory, which is shared with the Department of Theoretical and Applied Mechanics, is 40 feet wide by 147 feet long, occupying the central portion of the building to its full height. It is served by a 10-ton crane 50 feet above the floor. This laboratory, in addition to having a heavily reinforced floor for testing structures requiring special apparatus, contains an Emery-Tatnall testing machine of 3,000,000-pound capacity, a 600,000-pound Riehle testing machine, and a number of other relatively large standard machines. There is a second laboratory, also shared with the Department of Theoretical and Applied Mechanics, which is 24 feet wide by 147 feet long by two stories high, served by a crane 16 feet above the floor.

Cement and Concrete Laboratory.—Modern equipment is available in this laboratory for making the standard tests on Portland and other cements, and also for the tests and research on plain concrete. Storage bins, screens, scales, mixers, moist rooms, and a low-temperature unit provide for classroom work and research on the effect of materials, proportions, temperatures, and other factors governing the character and strength of concrete.

Soil Mechanics Laboratories.—These laboratories contain the equipment necessary to perform all of the common tests for identifying and classifying soils, and for investigating their mechanical and hydraulic proper-



Emery-Tatnall Testing Machine — 3,000,000-lb. Capacity

ties. Moist rooms, freezing chambers and special equipment are available for research. The laboratory is also provided with the various types of devices used in the field for measuring earth and water pressures, and for making soil explorations.

Bituminous Materials Laboratory.—The usual facilities for tests and research in asphalts, tars, and similar materials used in building construction, road building, and other engineering work are contained in this laboratory.

Non-Bituminous Materials Laboratory.—This laboratory contains the usual installation of rattlers, abrasion and impact machines, ovens, and other equipment needed for the tests and research on paving brick, building stone, concrete aggregates, and stone and gravel used in road building.

Wood Laboratory.—The wood laboratory is equipped for the various tests of wood specimens, and for testing and research on joint connector wood structures.

Sanitary Engineering Laboratory.—This building is modern in every respect and well equipped. It has a floor area of 5,000 square feet and provides classrooms, offices, and laboratories for instruction and research in sanitary engineering. Four large tanks, ten feet in diameter, two of which are 16 feet high and two 28 feet high, are an important feature. These tanks are intended mainly for the primary treatment of sewage in preparation for use in research, for the collection of fresh sludge and well-digested sludge, and for the generation of gas through the digestion of sewage solids. Sewage is supplied by a connection with the main city outfall sewer adjacent to the building.

Hydraulic Engineering Laboratory.—Under a cooperative agreement with the State Water Survey, civil engineering students may make use of the hydraulic engineering laboratory to be included in the State Water Survey Building for which funds were appropriated in 1945. This laboratory will be equipped with the facilities necessary for investigations of river flow and spillway capacities by means of models, underground flow, soil erosion, various hydraulic aspects of pump corrosion, and other factors concerned with the control and use of water.

Surveying Laboratory.—The equipment and facilities for work in surveying are housed in a separate building on the south campus, near the practice areas. Numerous transits, levels, plane tables, tapes, and smaller instruments are available for regular surveying practice, geodetic surveying, and photogrammetry. Several instruments of high precision are provided for advanced work. There is a sufficient number of instruments with all supplemental equipment for approximately 30 transit parties, 30 level parties, and 10 plane-table parties at the same time.

Summer Surveying Camp.—To provide additional facilities for surveying instruction, the University leases from the U.S. Forest Service a large camp in the Chippewa National Forest in northwestern Minnesota, about 25 miles northeast of Bemidji. The camp is located near the headwaters of the Mississippi River in a secluded region with topography ideally suited for field practice in plane, topographic, and route surveying and with numerous lakes and streams for hydrographic surveying. The 17 large buildings are on high ground between two small lakes and one-half mile from Lake Rabideau, which is two and one-half miles long. Many larger lakes are nearby. The buildings have a total floor area of 25,000 sq. ft. and have a capacity sufficient to feed and house 150 students and 15 staff members, and to provide drafting rooms, classrooms, a library, a recreation building, a small hospital, and service buildings. The nearby lakes offer excellent opportunities for swimming, canoeing, and fishing, the surrounding forest area attracts those interested in hiking, and playing fields are provided for outdoor games. Civil engineering students spend eight weeks at camp during the summer between the freshman and sophomore years. Instruction and field practice fill the normal working day but ample time remains for recreation.

Views of Civil Engineering Department's Summer Surveying Camp at Lake Rabideau, Minnesota

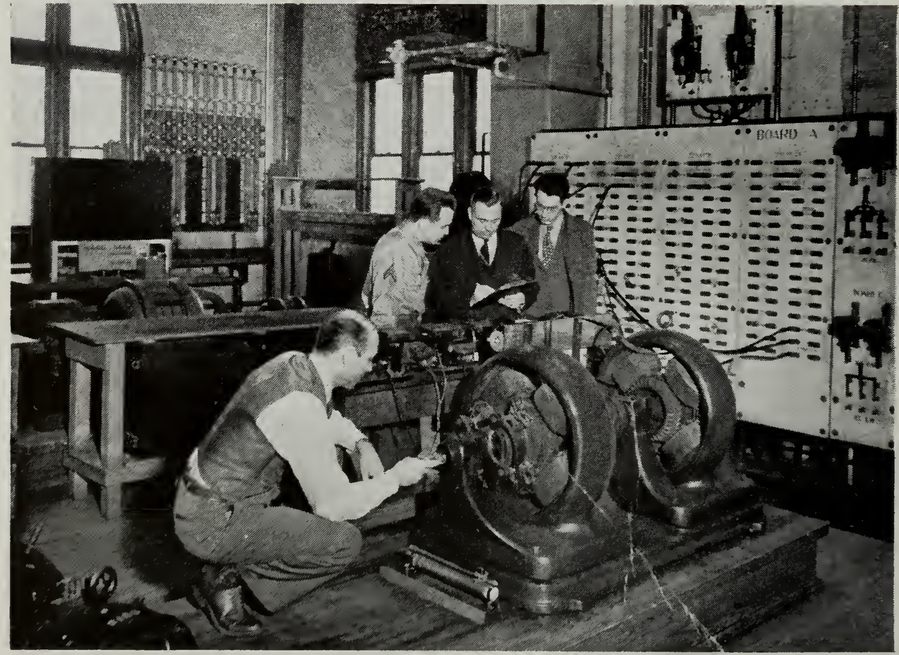
Drafting and Design Rooms.—The department has at its disposal eight large drafting rooms for junior and senior students in design work. Each student is thereby able to have his own desk for work at any time.

Electrical Engineering Laboratories and Equipment

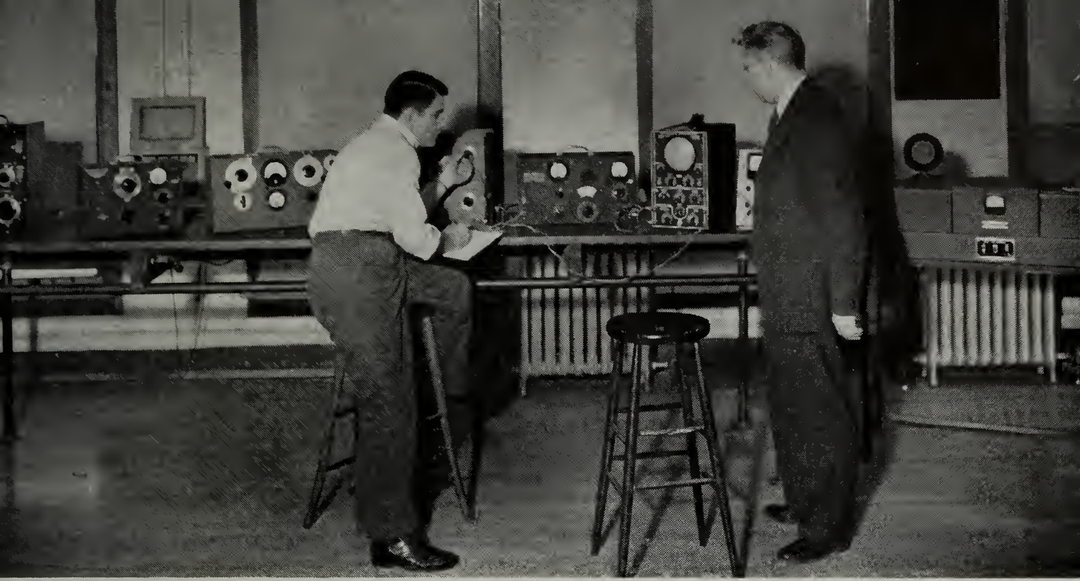
The laboratory facilities of the Department of Electrical Engineering include the dynamo laboratories, the calibration laboratory, the high voltage laboratory, the illumination and photometry laboratory, the radio laboratory, the electronics laboratory, the communication laboratory, the meter and relay laboratory, and the research laboratories.

Dynamo Laboratories.—The two dynamo laboratories contain a large assortment of electric generators, motors, and transformers together with auxiliary equipment and special devices used by junior, senior, and graduate students in their experimental studies. The equipment of these laboratories permits tests over a wide range of current, voltage, and frequency.

Calibration Laboratory.—This laboratory contains primary and secondary standards, including standard cells, resistances, potentiometers, and other devices necessary for maintaining the accuracy of the various types of electrical instruments used in the experimental work of the department. The



Dynamo Test — Electrical Power Laboratory



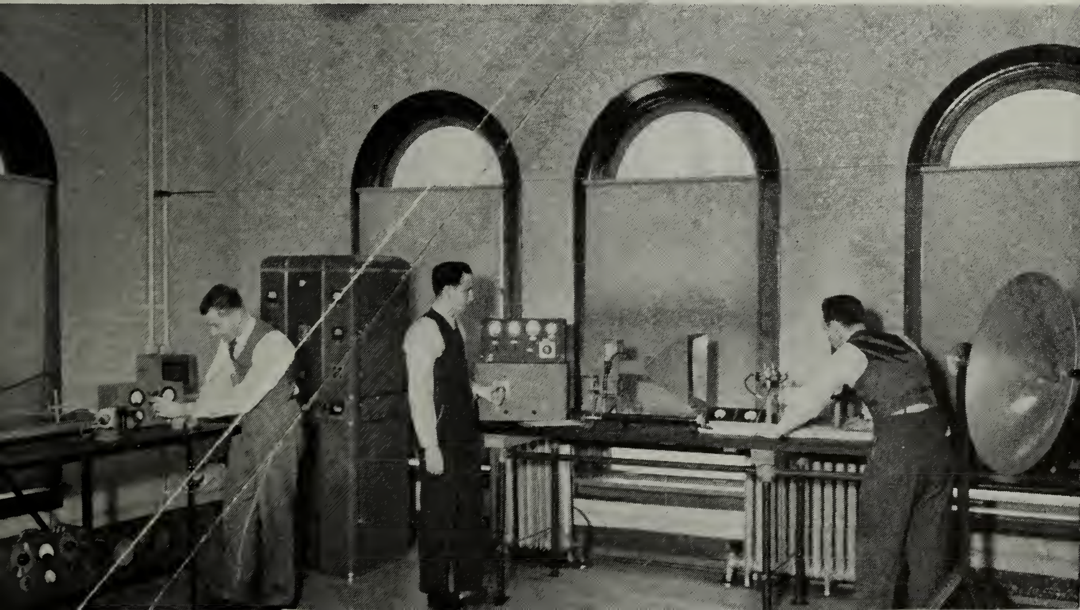
Radio Frequency Test — Radio Laboratory

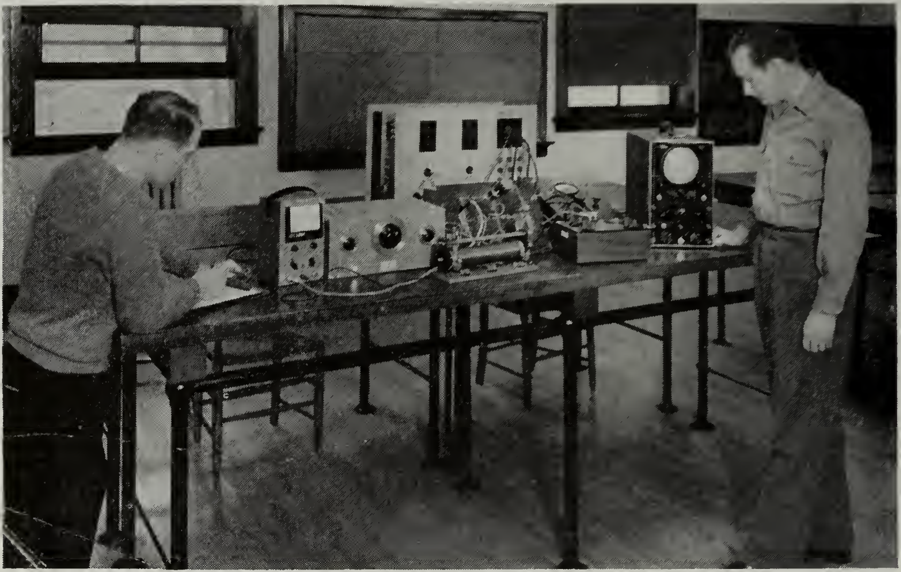
instruments used in the various laboratories are checked regularly in the calibration laboratory.

High Voltage Laboratory.—Equipment for the study of high voltage phenomena, with either continuous or alternating potentials, is housed in a building offering ample space for such studies. A surge generator of moderate capacity is available for surge testing.

Illumination and Photometry Laboratory.—Photometric dark rooms and a demonstration room with a seating capacity of about 100 persons are parts of this laboratory. The equipment includes an unusually complete assortment of devices to illustrate the principles and practices of lighting. The equipment in the field of colorimetry is particularly outstanding.

Super-High Frequency Propagation Test





Electronics Laboratory Equipment Test

Radio Laboratory.—In addition to the usual equipment for instruction in the principles of radio communication, the radio laboratory is provided with high and ultra-high frequency transmitters and receivers, television transmitting and receiving equipment, radio-frequency standards and full equipment for making radio frequency measurements and investigations, including radar and other ultra-high frequency applications.

Electronics Laboratory.—This laboratory is well equipped for the experimental work in the highly important and rapidly developing field of electronics. The apparatus includes the latest types available for the study of industrial applications of electronics, including resistance welding controls, high frequency heating, and industrial electronic controls.

Communication Laboratory.—This laboratory contains an artificial long transmission line, twelve miles of cable circuit and many pieces of special equipment used by students in their experimental studies of circuits and lines at telephone frequencies.

Meter and Relay Laboratory.—The equipment in this laboratory includes standards and special apparatus for studying the performance of watt-hour meters, protective relays, and other devices used in the recording of electrical energy and the protection of power transmission and distribution systems.

Research Laboratories.—These laboratories occupy several large rooms which are used mainly in connection with the Engineering Experiment

One of the Many Classes in General Engineering Drawing

Station activities of the department and other smaller individual research rooms used by graduate students and members of the department staff engaged in special investigations. Many special pieces of equipment, not associated with the regular equipment of other laboratories, are available for use in research. There is a well-equipped shop for the construction and repair of apparatus and a room supplied with a full assortment of glass working devices for the use of those who need glass apparatus in their research.

New Laboratories.—The Department of Electrical Engineering has received an appropriation of funds for the construction and equipping of a new laboratory building. Work on this development is under way. New laboratories to be included will be those for the study of servomechanisms and of engineering acoustics. The facilities of the other fields will be greatly enlarged.

General Engineering Drawing Laboratories and Equipment

The facilities of this department are modern and complete. The department has at its disposal drafting rooms and model equipment sufficient to accommodate one thousand students. It will soon have at its disposal practically all of the Transportation Building, thus increasing its facilities 50 per cent. Its facilities for the reproduction of drawings and printed material consist of a photostat, a large-size electric-driven continuous blueprinting machine with electric dryer, Directo and Ozalid developing machines, and a standard

Class Instruction in Descriptive Geometry

Drawing Room — Students at Work in Aircraft Drafting

Class in Blueprint Instruction

Colts Armory printing press with type and accessories. The pressroom houses several thousand zinc etchings on permanent mountings for problem use in courses in drawing and descriptive geometry. All specifications and instruction sheets for student work are printed by means of this equipment. The department owns a complete collection of modern drafting equipment for both display and classroom use.

Mechanical Engineering Laboratories and Equipment

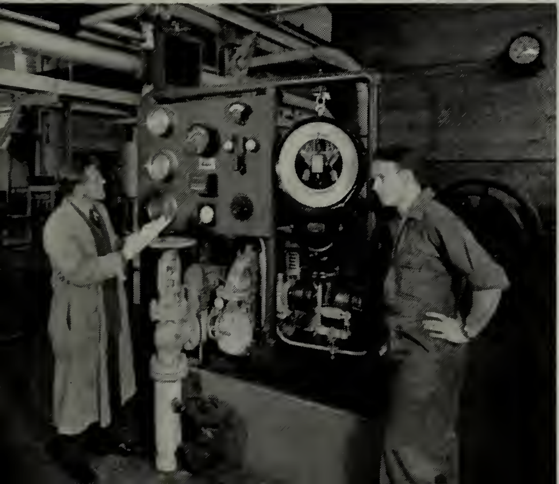
The laboratory facilities of the Department of Mechanical Engineering, not including those for design and computation, consist of two main units. One is the Mechanical Engineering Laboratory, the other the Shop Laboratories.

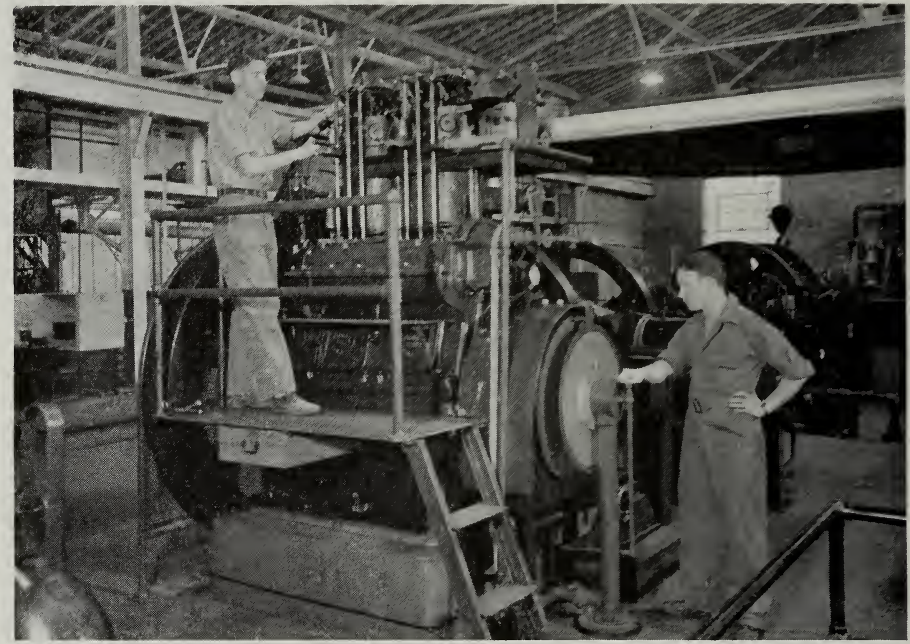
Mechanical Engineering Laboratory.—This laboratory houses the steam power, internal-combustion engine, fuel-testing, heating, ventilating, air conditioning, and refrigeration equipment used in the testing and experimental work required in the mechanical engineering curriculum. Ample provision is also made for graduate and research work. The principal prime movers consist of three steam engines, two steam turbines, three oil engines, one gas engine, and three automobile motors; all of these prime movers are equipped with complete auxiliary testing facilities. The pumping machinery consists of a compound direct-acting duplex steam pump, a number of injectors, and two motor-driven centrifugal pumps.

For problems pertaining to air compression and refrigeration, the following equipment is available: A two-stage air compressor having compound steam cylinders, two motor-driven air compressors, an ammonia compressor, and a household refrigerator demonstrating model.

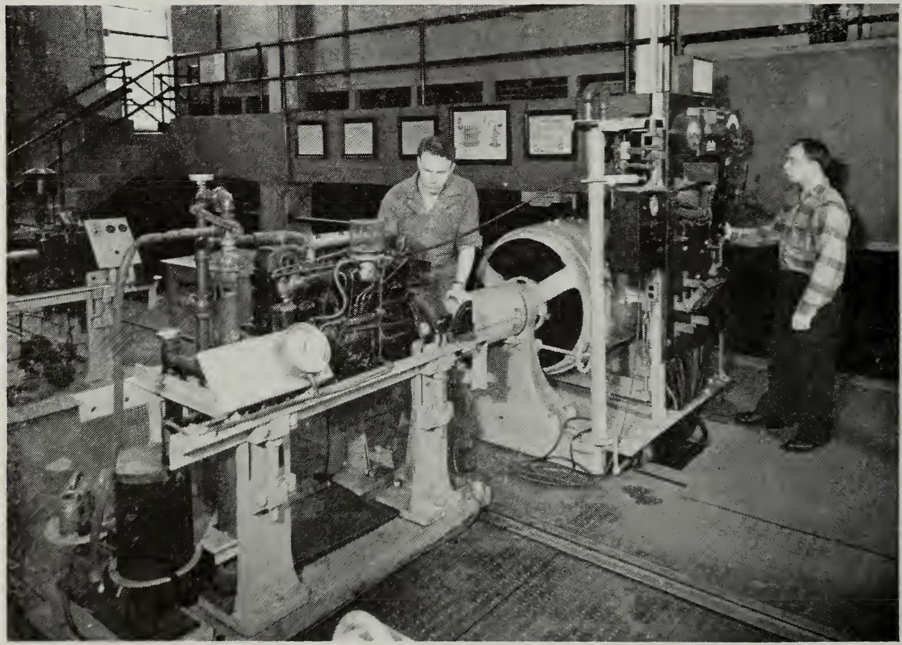
The equipment available for instruction and research in the heating, ventilating, and air conditioning field includes a steam-radiator testing booth, a hot-water radiator testing booth, an air conditioning unit including an air washer and various types of heating and cooling coils, a number of fans, a heating boiler equipped with

Small Turbine





Vertical Diesel Engine



Automobile Engine — Dynamometer Set

Experimental Air Conditioning Equipment

stoker, a warm-air furnace testing plant with the necessary auxiliaries, and a special low-temperature testing plant.

In addition to the equipment enumerated above and the usual small instruments required in testing work, the Mechanical Engineering Laboratory has a number of dynamometers and brakes, flow meters, fuels and gas calorimeters, coal-analyzing equipment, clutch and belt testing apparatus, equipment for testing brakes and speed reducers of various types, and a motor-generator set.

The Shop Laboratories.—In these buildings are the pattern laboratory, foundry laboratory, machine laboratory, and heat treatment laboratory. All of these laboratories are concerned with the preparation of parts used in the production of machinery. Their facilities are available for research and graduate work as well as for undergraduate work.

The pattern laboratory is equipped with the necessary machines and tools for the designing and making of metal and wood patterns for quantity production. The equipment available for instructional work in the foundry laboratory includes complete apparatus for the testing and grading of foundry sands, various types of molding machines, a cupola for the melting of gray iron, and a gas furnace for the melting of non-ferrous metals, core ovens, and all machinery necessary for cleaning castings.

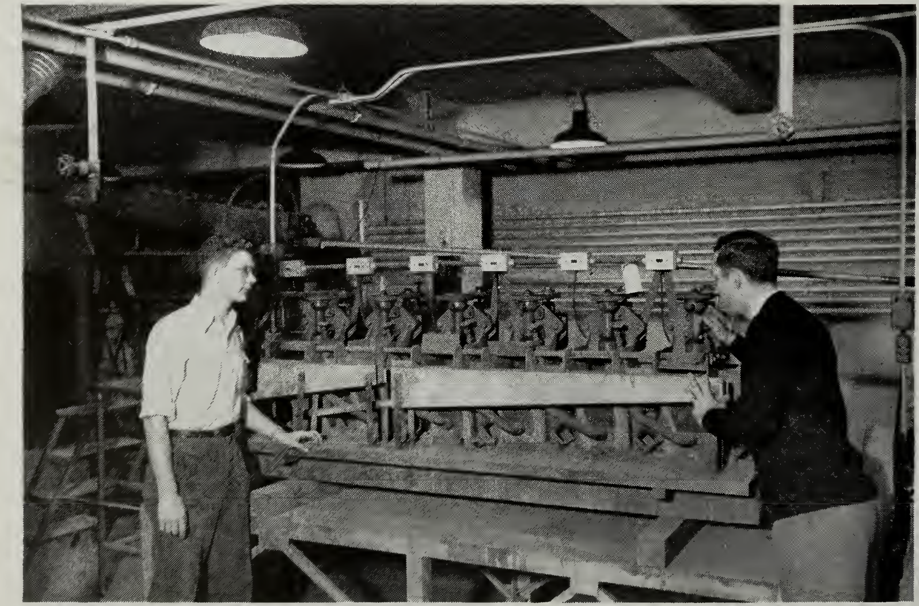
The machine laboratory equipment consists of lathes, milling and gear-cutting machines, shapers, planer, precision and tool grinders, drilling and boring machines, tool dynamometers (for measuring forces exerted upon lathe tools and drills when cutting metal), and apparatus for testing lubricating oils. In addition, the machine laboratory has a complete set of special tools, jigs, and fixtures for demonstrating the methods used in a modern production shop.

In the heat treatment laboratory the equipment includes gas and electric furnaces, recording pyrometers, a tensile-testing machine, hardness-testing machines, polishing and etching apparatus, metallurgical camera, and microscopes for the study of the physical properties of metals.

Mining and Metallurgical Engineering Laboratories and Equipment

Laboratories housed in the building called the Mining Laboratory include the sampling and grinding laboratory, the chemical and physical laboratory, the coal preparation and ore dressing laboratory, the ventilation laboratory, and the drilling and blasting laboratory.

Sampling and Grinding Laboratory.—Complete field and laboratory equipment is available for sampling and for the reduction of samples. The grinding room is equipped with a jaw crusher, coal grinders and pulverizers, disc-type pulverizing mills, testing sieves and sieve-test apparatus, sample mixer, etc.



Flotation Cells Used in Mineral Dressing

Arc Welding in Metallurgical Laboratories

Chemical and Physical Laboratory.—This section of the laboratory is used for control of various coal-cleaning, coal-utilization, and ore-dressing tests. Chemical equipment is available for all types of analytical work, including complete equipment for the proximate or ultimate analysis of coal, sulphur in coal, fusibility of ash, and the calorific value of coal. Special apparatus includes a gas calorimeter, sulphur turbidimeter, colorimetric pH comparator, combustion trains, and specific gravity apparatus for solids, liquids, and gases. Petrographic and mineral dressing microscopes are available for studying special coal and ore problems. A well-equipped balance room adjoins this laboratory.

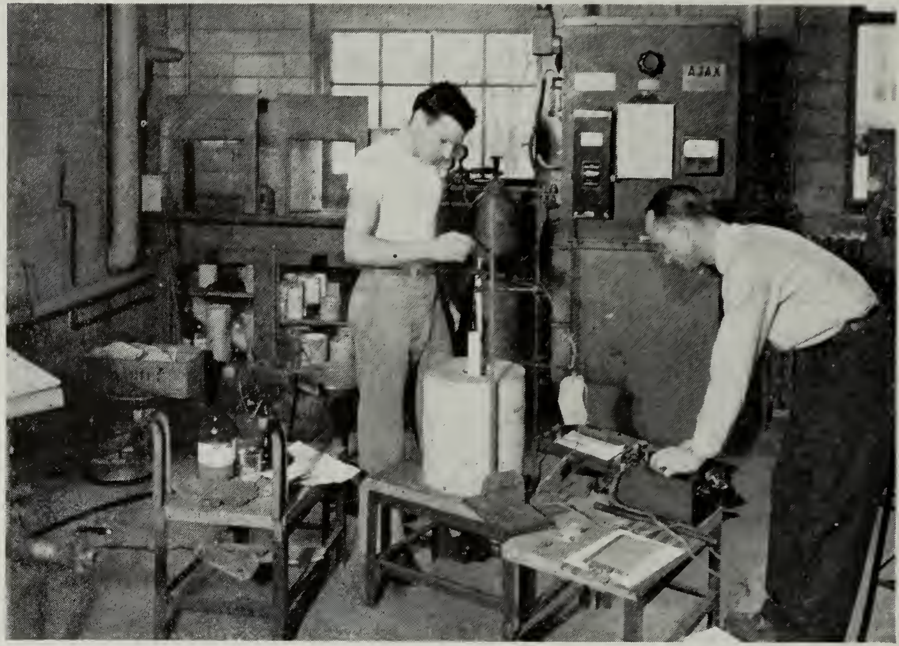
Coal Preparation and Ore Dressing Laboratory.—A large portion of the equipment in the main laboratory is special apparatus for the testing of coal. Equipment is available for float-and-sink tests for any size sample and for any size of coal.

Apparatus or machinery of special application to coal preparation problems includes coal crushers and pulverizers, vibrating screens, wet concentrating tables, jigs, a sand-flotation unit, a centrifugal dryer, and filters. A briquetting press is available for the making of coal briquets.

In addition, equipment that has a special application to ore-dressing problems is as follows: coarse rock breakers, rolls, pebble, ball, and rod mills, hydraulic and mechanical classifiers, magnetic separator, froth flotation units, and a large drying oven.

Equipment for Studying Mine Ventilation Problems

Metallograph for Studying Microscopic Structure of Metals and Alloys



High Frequency Induction Equipment for Melting Metals and Alloys

Ventilation Laboratory.—A collection of the various kinds of miners' lights, dating from the primitive fire wheel to the modern types of flame safety lamps and approved electric cap lamps, is one of the most complete in the country. A photometer and gas-analysis apparatus, as well as gas detectors, are available for research and instruction purposes. In addition, mine-ventilation models, fans, and a duct system comprise a very important part of the ventilation laboratory. Miscellaneous equipment consists of anemometers, sling psychrometers, katathermometers, Wahlen and Ellison gages, etc.

Drilling and Blasting Laboratory.—Representative drilling machinery and accessories consist of hand and electric augers, rock drills of various types, a portable diamond drill, a gas-fired heating furnace for drill steel, and a compressed-air drill-sharpener. Dummy cartridges, squibs, fuses, electric detonators, tamping tools, blasting machines, circuit testers, and shot-firing equipment are to be found in this laboratory.

The laboratories housed in the building called the Metallurgy Laboratory include the welding laboratory, the electrometallurgical laboratory, the furnace and heat treatment laboratory, the metallographic laboratory, and the research laboratory. The Metallurgy Laboratory, erected in 1936, is a fireproof structure adjoining the Mining Laboratory.

Welding Laboratory.—The equipment in this laboratory includes two welding booths and a Lincoln electric arc-welder, two high-speed cutoff machines, a surface grinder, fatigue machines for rotating beam and sheet specimens, Izod-Charpy-Tension impact machine, and Rockwell and Brinell hardness testing apparatus. Adjoining the laboratory is a specially equipped machine shop for construction of special research apparatus.

Electrometallurgical Laboratory.—This laboratory is equipped with tables, ventilating hood, voltmeters, ammeters, potentiometers, and accessory electrical equipment for instructional and experimental work in the field of elecrometallurgy. It is supplied with gas, air, water, and both direct- and alternating-current.

Furnace and Heat Treatment Laboratory.—This laboratory is equipped with six electrical resistance furnaces for heat treatment of steels, Sentry and high-temperature gas furnaces for heat treatment of tool and die steels, a Globar sintering furnace, three gas-fired muffles for assaying of ores, and one salt-bath furnace; one 50-pound high-frequency induction furnace and one 50-pound electric-arc furnace for melting metals and alloys; two complete sets of apparatus for determining the hardenability of steels; an apparatus with attached furnace for growing single crystals of metals and alloys; and one high-speed recording potentiometer with a reaction rate of 0-3000 deg. F. in two seconds. There is also a Riehle Universal 40,000-pound testing machine for experimental work. The facilities of the Talbot Laboratory (see page 36) are used for undergraduate instruction and for large specimens in determining the mechanical properties of metals and alloys.

The Metallographic Laboratory.—This laboratory includes a grinding room and fume hood, separated from the microscope room by a glass partition. The equipment includes carborundum grinders, endless belt grinding machines, 13 wet polishing wheels, 15 metallographic microscopes (Leitz and Bausch and Lomb), large work tables, and etching equipment. In an adjoining room is located a Leitz Metallograph, a macro-camera, an apparatus for levigating polishing compound, and a film drier. There are large photographic rooms for developing and printing photomicrographs. All the rooms in this laboratory are ventilated with tempered air.

Research Laboratories.—These rooms are mainly reserved for staff research work and for graduate research in the preparation of theses. Special items of equipment, such as a Zeiss Neophot metallograph and Diamo-Brinell hardness testing equipment, are to be found in the research laboratories.

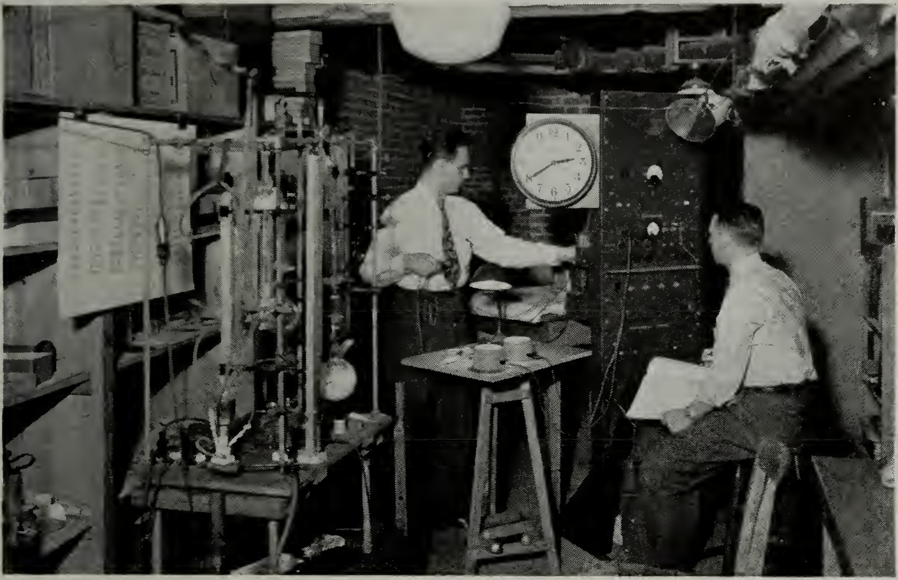
Physics Laboratories and Equipment

The laboratories of the Physics Department are of three kinds. First, there are three large laboratories for instruction in the elementary courses. In these all undergraduate engineers learn the basic principles of physical measurement and experimentation, carrying out in the course of a year approximately 30 experiments, illustrative of fundamental physical ideas, with equipment of sufficient quality to challenge them to achieve a high standard in precise physical measurements.

Second, there are instruction laboratories for advanced undergraduate and graduate students. One laboratory is well equipped for electrical and magnetic measurements, including work in vacuum tube circuits, another for work in light and spectroscopy, and a third for a variety of experiments in modern research methods and techniques. A biophysics laboratory is being built up. The equipment in these laboratories is of research quality and students are encouraged to approach the experiments as research problems.

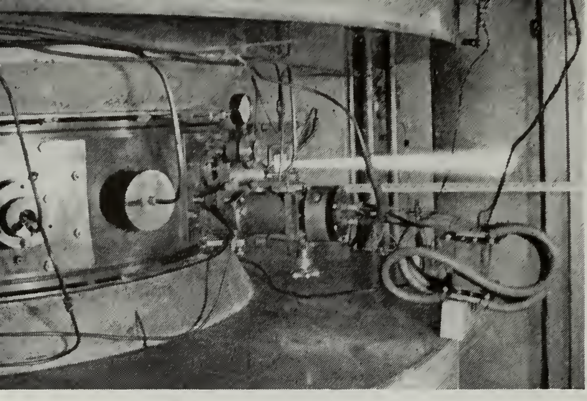
Betatrons and Cyclotron.—Third, the research laboratories supply facilities for original investigation in many branches. There are three general lines of research in nuclear and high energy physics. One centers about the betatrons or electron accelerators. A 20-million-volt and a 4-million-volt betatron are in operation and a 250-million-volt machine is being designed and constructed. The betatron program will be housed in a large, well-equipped laboratory building now under construction. The cyclotron, which accelerates deuterons to an energy of 10 million electron volts, is the tool for another program of experiments in the interaction of heavy particles with each other and with atomic nuclei. The cyclotron is housed in a separate laboratory. In a third series of experiments radium sources amounting to 350 milligrams produce neutrons for investigations of their interactions with nuclei of atoms.

Optics Laboratory for Seniors and Graduate Students

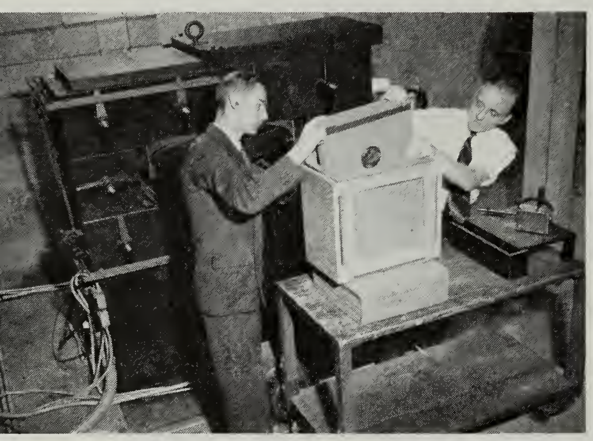


Graduate Students Working on Neutron Physics

Advanced Electrical Measurements Laboratory



Side View of 10,000,000-Volt Deuteron Beam from the Cyclotron



Measurement of X-Ray Dose in Tissue-Like Material with the Betatron

A radiochemist on the Physics Department staff serves the needs of nuclear physics research and, in cooperation with the Chemistry Department, offers instruction in this new and important field.

Excellent equipment for investigations in optical spectroscopy and in mass spectroscopy is also available.

Facilities to aid research and teaching programs are freely available, including gas, direct and alternating current at several voltages, compressed air, vacuum and liquid air and distilled water. There is a well-supplied stockroom operated by an experienced storekeeper. There are two work shops in the Physics Laboratory, one for the mechanicians and one for instructors and advanced students. The new betatron laboratory will contain a large machine shop, a glass-working shop, and an electronics shop. Two glass blowers serve the department. An excellent working library of periodicals and books of special use in connection with instruction and research programs is maintained in the Physics Laboratory.

Theoretical and Applied Mechanics Laboratories and Equipment

The laboratories of the Department of Theoretical and Applied Mechanics are housed mainly in two buildings, the Arthur Newell Talbot Laboratory and the Car

Wilson Cloud Chamber Apparatus

Wheel Testing Laboratory. The former building is four stories in height, built in the form of an H with two wings 187 by 50 feet and a stem 110 by 92 feet. The Department of Theoretical and Applied Mechanics occupies the reinforced concrete laboratory, two materials testing laboratories, the fatigue of metals laboratory, the hydraulics and fluid mechanics laboratory, the concrete research laboratory, the plastics laboratory, the vibration laboratory, several smaller laboratories, and a large machine shop.

Reinforced Concrete Laboratory.—This room, 40 feet wide by 147 feet long, occupies the central portion of Talbot Laboratory from the basement to its full height. It is served by a 10-ton crane 50 feet above the floor. Here are tested large structural and machine parts such as full-size concrete footings, concrete bridge slabs, concrete frames and columns, railroad rails, railroad car axles and car wheels. The laboratory contains an Emery-Tatnall testing machine of 3,000,000-pound capacity with an electric elevator, a 600,000-pound capacity Riehle testing machine and a number of other large machines for making tests in bending, tension, compression, torsion and impact. A special feature is the heavily reinforced floor which is constantly in use for making special tests. The use of this testing equipment is shared with the Department of Civil Engineering.

Materials Testing Laboratories.—These laboratories, which occupy the entire second floor of the west wing of the building, are used mainly

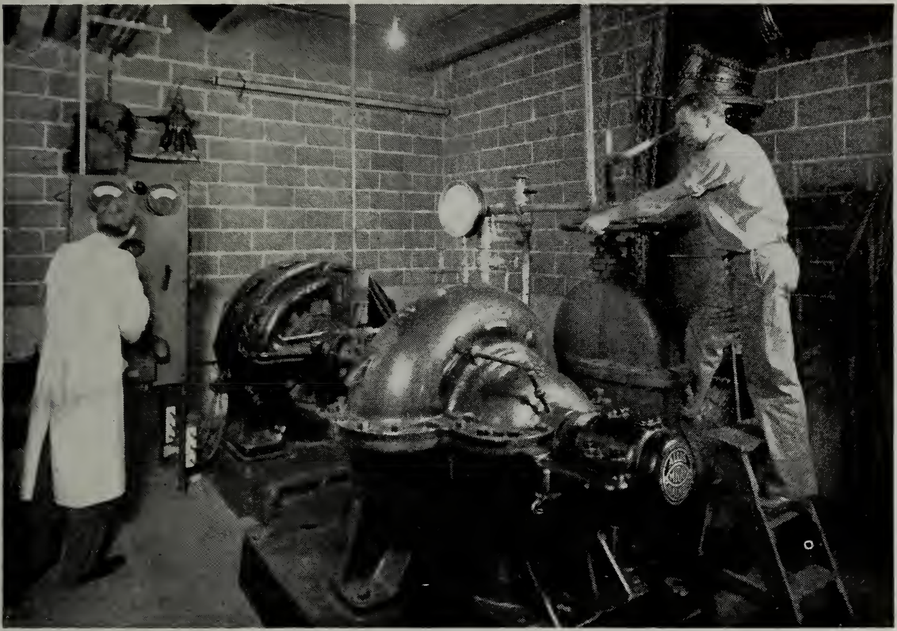
Students Making Hardness Tests of Steel and Other Materials

Students Making Repeated Load Tests of Steel and Cast Iron

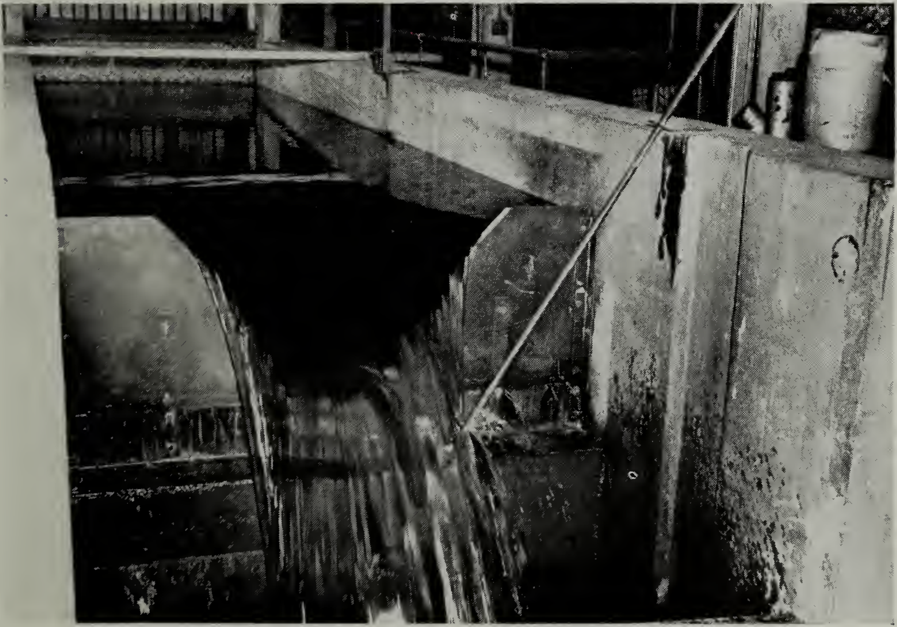
for the instruction of students. They contain ten testing machines with capacities of from 50,000 to 100,000 pounds, equipped with individual motor drives. The laboratories also contain a considerable number and a great variety of smaller hand- and machine-operated machines for making student and research tests in torsion, repeated loads, hardness, impact, and effect of temperature.

Fatigue of Metals Laboratory.—This laboratory, devoted to the study of the behavior of metals under repeated loading, is unusually well equipped for this purpose; there are many repeated stress testing machines of all types and sizes. The laboratory also contains equipment for making tests in tension, compression, hardness and impact, as well as furnaces for heat treatment of specimens and testing equipment. Many of these machines were designed by the staff of the laboratory and constructed in the laboratory shops.

Concrete Research Laboratory.—This laboratory occupies the basement and a portion of the first floor in the southeast wing of the building. It has storage space for concrete materials and contains equipment for making plain and reinforced concrete. This equipment includes concrete mixers, a concrete saw, vibrators, drying ovens and a refrigerating unit. Large moist rooms with temperature control provide standard curing conditions for test pieces. The laboratory is served by a six-ton crane and contains the various types of machines needed for testing cement, sand, aggregates, concrete and reinforced concrete, including machines for making tests under impact and fatigue loads.



Electric-Driven Centrifugal Pump Which Delivers 13,500 gal. per min.

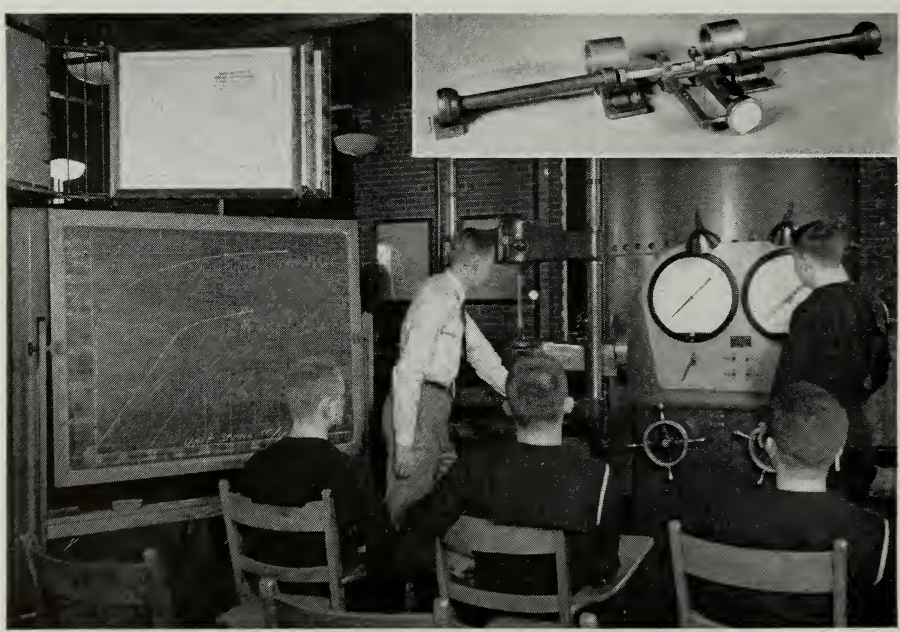


V-Notch Weir to Measure Discharge from Pump with Capacity of 13,500 gal. per min.

Hydraulics and Fluid Mechanics Laboratory.—The hydraulics and fluid mechanics laboratory occupies the basement and first floor of the west wing. A standpipe six feet in diameter and 60 feet high, located in one corner of the laboratory, supplies the water, which is pumped into it by five centrifugal pumps from a sump in the basement. Where larger quantities of water are needed, a centrifugal pump can furnish 13,500 gallons per minute. A special channel is available to handle the large flow from this pump. The weighing tanks are located in the basement, with scales and gauges on the first floor where are placed the weirs, orifice tanks, meter-testing equipment, venturi meters, centrifugal pumps, hydraulic ram, turbines, cavitation unit, viscometers, and apparatus for demonstrating turbulent and lamellar flow and for determining Reynolds' number with both water and oil. All of this equipment is used for student experiments and for investigating engineering problems in hydraulics and fluid mechanics.

Plastics Laboratory.—This room is equipped with complete temperature and humidity control and contains machines and equipment especially designed to make standard and special tests of plastics.

Vibration Laboratory.—To supplement classroom instruction, work is done here in the vibration of machinery and structures, a field which has become of great importance due to the increase in speed of engineering parts. The laboratory contains equipment and apparatus designed to demonstrate



Testing an Aluminum Alloy to Determine Its Strength. Upper Right View Shows Details of Specimen Holders and Strain-Measuring Apparatus and study the various types of vibration, the ways in which vibrations are produced, and how they may be prevented.

Miscellaneous Laboratories.—Several laboratories are equipped for special work such as photography, metallographic investigation, photoelastic studies and creep tests of various kinds. Each of these laboratories is equipped with the special apparatus needed for the various investigations, many of which are carried on in cooperation with industry.

Machine Shop.—In this large and well-equipped shop the specimens and apparatus for student use are made; here also is made much of the research apparatus which is needed in the investigations which are carried on in the various laboratories.

Car Wheel and Brake Shoe Testing Laboratory.—This is a separate building housing a machine for testing car wheels and brake shoes which is capable of exerting a shoe pressure of 22,000 pounds and operating at speeds up to 100 miles per hour. It is fully equipped for measuring and recording the tangential pull of the brake shoe. This laboratory also contains a large repeated load machine for testing railway car wheels and axles for fatigue failures.

ADMISSION

ADMISSION TO THE COLLEGE OF ENGINEERING is contingent on admission to the University of Illinois under the regulations administered by the Registrar of the University. The credits required for admission to the undergraduate departments may be secured in three ways: (1) by *certificate* from an accredited high school or other secondary school; (2) by *examination;* and (3) by *transfer* from another university or college of recognized standing. The following is a condensed statement of the conditions of admission as they affect students entering the College of Engineering. The Registrar should be consulted concerning all questions of detail arising in any particular case.

Official credentials should be sent directly from each institution previously attended to the Registrar at Urbana soon after the close of the school year, and on receipt of these, the Registrar will communicate with the applicant regarding his admission. If the credentials are not received until the week before the opening of the University, it may not be possible for the Registrar to notify the applicant of his status prior to his arrival on the campus. The University will not issue a permit to enter except on the basis of official detailed credentials filed in advance which meet the requirements for admission. Freshmen are required to be on the campus for the freshman week program preceding registration in September.

Applicants for admission who come from foreign countries must bring complete official credentials. Certificates from Oriental and Slavic countries must be accompanied by certified translations.

Qualified applicants are admitted at the beginning of any semester. Applicants for admission to the College of Engineering will find it of some advantage to enter at the beginning of the first semester rather than the second or the summer session.

Physical Examinations

All students, except those entering only for summer sessions, who have not previously taken a physical examination at the University, must take such an examination, veterans of World War II excepted. Before registration, a new student must secure an appointment with the University Health Service for his physical examination. The examination is given by the University at the time of appointment without cost to the student. If the student fails to take the examination at the appointed time and does not present an excuse from the Registrar, a fee of $5.00 is charged to provide for a special examination, or he will be required to be examined at his own expense outside the University in a manner meeting the requirements of the Health Service.

General Requirements for Admission to the University

Age.—An applicant must be at least sixteen years of age. The dean of the college concerned, however, may admit on petition a student fifteen years of age who meets all other requirements for admission and who is to reside, while attending the University, with his parents or guardian, or with someone selected by them.

High School Graduation.—To be admitted by certificate, an applicant must be a graduate of an accredited secondary school. If the school is in Illinois, it must be accredited by the University of Illinois; if located elsewhere, its rating must be equivalent to accreditation by the University of Illinois. Conditions under which non-graduates may be admitted are given below.

High School Scholarship.—An applicant for admission to the University whose rank in scholarship is in the upper three-quarters of his graduating class and who meets the requirements as stated below is admitted by certificate to full freshman standing. Furthermore, the Registrar is authorized to admit, without adhering to the usual requirements as they pertain to majors and minors, an applicant whose rank in scholarship is in the upper fifty per cent of his graduating class. Such a student, however, must present those specific high school courses that are prerequisite to courses in the curriculum which he desires to follow in the University.

A graduate of an accredited high school whose rank in scholarship is in the lowest quarter of his graduating class and who meets the requirements as stated below is admitted by certificate to probationary status and, in connection with his first registration in the University, is required to take such tests as may be prescribed by the Student Personnel Bureau. Such a student, immediately upon registration, is placed under the special supervision of the dean of the college. He may be required by the dean or director to carry a reduced program of work or a program especially arranged to meet his needs.

The student's rank is to be based on work completed in grades nine, ten, eleven, and twelve in the case of four-year high school and on work completed in grades ten, eleven, and twelve in the case of three-year senior high schools.

Fifteen Units Required.—Fifteen units of acceptable secondary school work are required, including the following:

I. Two majors and one minor, selected from Groups 1-5 below. One of the majors must be English. (See definitions of *Unit, Major,* and *Minor* below.)

II. A total of at least nine units from the fields of English, foreign language, mathematics, science, and social studies, including preparation amounting to a major or minor sequence in at least three different fields. (See Groups 1-5 below.)

III. All subjects prescribed for the curriculum which the applicant desires to enter. (See paragraph on *special* requirements below.)

IV. The six remaining units necessary for admission may be selected from any of the high school subjects which are accepted by an accredited school toward its diploma and which meet the standards for accrediting as defined by the University of Illinois. Fractional credits of the value of less than one-half unit will not be accepted. Not less than one unit of work will be accepted in a foreign language, elementary algebra, plane geometry, physics, chemistry, or biology.

The University realizes the obligation of the high school to meet fully the needs and interests of all its pupils. It, therefore, believes that high schools should offer courses in such fields as agriculture, art, commerce, home economics, industrial arts, music. Furthermore, by accepting them for admission, it recognizes that they contribute to satisfactory preparation for college work.

Definitions

Unit.—A *unit course of study* in the secondary school is a course covering an academic year and including not less than the equivalent of 120 sixty-minute hours of classroom work. Two hours of work requiring little or no preparation outside the class are considered as equivalent to one hour of prepared classroom work.

Major.—A *major* consists of three unit courses in one field. (See special requirements for a major in each of the various fields as stated below.)

Minor.—A *minor* consists of two unit courses in one field. (See special requirements for a minor in each of the various fields as stated below.)

Majors and Minors

The required majors and minors defined above may be selected from the following five groups:

(1) **English.**—(In all cases one major must be in English.) Only courses in history and appreciation of literature, composition (including oral composition when given as a part of a basic English course), and grammar will count toward a major.

(2) **Foreign Language.**—Three units in one language constitute a major. Two units in one language constitute a minor.

(3) **Mathematics.**—Only courses in algebra, plane geometry, solid and spherical geometry, and trigonometry will be accepted toward a major or minor in this subject. (General mathematics may be accepted in lieu of algebra and geometry in cases where the content of the course is essentially the same as that ordinarily included in algebra and geometry.)

(4) **Science.**—(Including physics; chemistry; biology, or botany and zoology; general science, or physiology and physiography; astronomy; and geology.) The three units required for a major must include at least a total of two units chosen from one or more of the following subjects: physics, chemistry, botany, and zoology. Biology may be offered in place of botany and zoology. The two units required for a minor must include at least one unit from the above subjects.

(5) **Social Studies.**—(Including history, civics, economics, commercial or economic geography, and sociology.) The three units required for a major must include at least two units in history. The two units required for a minor must include at least one unit in history.

Special Requirements and Recommendations

The *special* minimum requirements for admission to the various curricula of the College of Engineering are: English, three units; algebra, one and one-half units; plane geometry, one unit; and solid geometry, one-half unit. (A student may enter the College of Engineering with a deficiency in solid geometry or advanced algebra, or both, provided he meets all other entrance requirements. His deficiency in mathematics must be removed during his first year of residence.)

As a further aid to the high school student who plans to enter any one of the curricula of the College of Engineering it is recommended that he present, in addition to the *special* minimum requirements listed above, at least a *minor* in the following subjects, stated in the order of preference: (1) French or German or Latin; (2) science; (3) social studies; and (4) industrial arts.

Graduates of Unaccredited Secondary Schools

Graduates of unaccredited secondary schools which offer four years of instruction are admitted by examination. The Registrar, however, is authorized to admit a student who is a graduate of such an unaccredited secondary school and whose general scholarship rank is in the upper twenty-five per cent of his graduating class, subject to his passing at the University in advance of admission: (1) a test in English composition and rhetoric; and (2) such other examinations and tests in high school subjects as may be necessary to complete the University entrance requirements and the special requirements of the chosen curriculum.

Students from Accredited Secondary Schools Who Are Not Graduates

An applicant who has attended, but who has not been graduated from, an accredited school, must pass entrance examinations in English composition and four units in additional subjects to be designated by the University authorities. The remaining units required for admission may also be made in entrance examinations or may be offered by certificate from an accredited school.

Graduates of Three-Year Senior High Schools

In the case of graduates of a school organized as a three-year senior high school, including grades ten, eleven, and twelve, at least twelve units must have been taken in the senior high school. Two majors and one minor, or four minors, must be from the fields of English, foreign language, mathematics, science, and social studies. Either a major or a minor must be from the field of English. One unit of a foreign language and one unit of mathematics may be accepted from work completed in the ninth grade as a part of the majors and minors, provided at least seven units of senior high school work have been completed in subjects included in the above enumerated fields. The remaining five units may be selected from any of the senior high school subjects which are accepted by an accredited high school toward its diploma and which meet the standards for accrediting as defined by the University. The transcript of credits certified by the senior high school must show any credit in mathematics or foreign language accepted from the ninth grade if these subjects have been continued in the senior high school. Fractional credits of the value of less than one-half unit will not be accepted. Not less than one unit of work will be accepted in a foreign language, elementary algebra, plane geometry, physics, chemistry, and biology.

Unclassified Students

Persons over twenty-one years of age may be admitted as unclassified students (not candidates for a degree) in the undergraduate colleges at Urbana, provided they secure the recommendation of the instructor whose work they wish to take and the approval of the dean of the college. They must give evidence that they possess the requisite information and ability to pursue profitably, as unclassified students, their chosen subjects, and they must meet the special requirements of the college as stated above.

An unclassified student is not matriculated and must pay a fee of $7.50 a semester in addition to the regular tuition fee.

No one may enroll as an unclassified student in any school or college of the University *for more than two years,* except by special permission, application for which must be made through the dean of the college.

Admission to Correspondence Courses

Correspondence courses are open to any applicants who can meet the University entrance requirements and also to persons eighteen or more years of age whose applications are approved by the Director of University Extension. For further information address the Director, 118a Illini Hall, Champaign, Illinois.

Admission to the Graduate School

Admission to the Graduate School may be granted to graduates of institutions whose requirements for the bachelor's degree are substantially equivalent to those of the University of Illinois. Admission may be to full graduate standing, to graduate standing with certain deficiencies to be removed, or to special status without reference to a degree. There are special scholastic requirements for admission to graduate work in chemical engineering. Admission to the Graduate School does not, however, imply admission to candidacy for a degree, and gives no right or claim to be so admitted. A mere accumulation of "credits" or "grades" is not sufficient. Application blanks for admission may be secured from the Registrar. Every applicant must submit with his application for admission an official transcript of his college record. Further information is given in the *Announcement of the Graduate School,* copies of which may be obtained by addressing the Dean of the Graduate School, 109 Administration Building, Urbana, Illinois.

CURRICULA AND DEGREES IN ENGINEERING

EACH OF THE FOLLOWING ELEVEN CURRICULA, leading to the degree of Bachelor of Science, may ordinarily be completed in a period of four years. The degree of Master of Science may be earned in one additional year. The professional degrees of Civil Engineer, Electrical Engineer, Mechanical Engineer, etc., follow the B.S. or M.S. degree in consequence of professional practice over a period of not less than four years and the presentation of a thesis based on some engineering work of an original character. The significance and importance of these advanced degrees to the engineer of the future are discussed in the section on graduate work (page 104).

Elective courses are specified in each curriculum under descriptive terms as follows: *non-technical electives* which, with few exceptions, are restricted to courses outside the College of Engineering; *technical electives* which include all courses in the College of Engineering not required in the student's curriculum, excepting Engineering 10, 20, 39, 40, 41, 92, and all elementary work in drawing (some courses in other colleges are considered *technical* for purposes of this requirement); *approved electives* which include both non-technical and technical electives as defined above; and *technical options* which include only stated technical courses within definite fields of knowledge related to the subject-matter of a particular curriculum. These latter electives are not options within a curriculum in the sense defined below, but merely restricted technical elective courses.

Most of the curricula of the College of Engineering provide the opportunity for concentration of the student's effort in the senior year along lines of his particular interest, within the broad field of his chosen curriculum. This is accomplished by *curriculum options,* which are groupings of subject-matter related to recognized fields of concentration in professional engineering practice. Examples are the highway, hydraulic, sanitary, structural, and railway options in the Civil Engineering curriculum. This arrangement secures the demonstrated advantages of the more flexible and completely elective system prevailing in some quarters, and it preserves the virtues of a prescribed curriculum for the guidance of students whose meager practical experience does not avail them much in rounding out their educational program. Senior theses further emphasize the field of concentration.

In all curricula no less than one year of college work in one modern language (English, French, German, or Spanish) may be substituted for the approved elective to the extent of the hours specified in a particular curriculum.

A description of the individual courses offered in each department of the College of Engineering is given in a following section. For a description of courses offered in other colleges and schools of the University, some of which are included in the curricular requirements of engineering students, the reader is referred to the *Annual Register* of the University. (Requests for copies of the *Annual Register* should be addressed to the Registrar, Urbana, Illinois.) Names of departments and divisions are abbreviated in the listing of courses in the curricula, as follows:

Aero.E.	Aeronautical Engineering	Geol.	Geology
Agr. Econ.	Agricultural Economics	Math	Mathematics
Agr.E.	Agricultural Engineering	M.E.	Mechanical Engineering
Bact.	Bacteriology	Met.E.	Metallurgical Engineering
Cer.E.	Ceramic Engineering	Min.E.	Mining Engineering
Chem.	Chemistry	P.H.	Public Health
C.E.	Civil Engineering	Phys.	Physics
Econ.	Economics	Rhet.	Rhetoric
E.E.	Electrical Engineering	T.A.M.	Theoretical and Applied Mechanics
G.E.D.	General Engineering Drawing	Zool.	Zoology

Common Program for Freshmen

Freshmen in the College of Engineering take this program unless otherwise specified in the curricula outlined on following pages.

First Year

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
Chem. 2 *or* 3—Inorganic Chemistry	3 or 4	Chem. 4—Metallic Elements	4
G.E.D. 1 *or* 4—Elements of Drawing	4	G.E.D. 2—Descriptive Geometry	4
Math. 2—Advanced Algebra	3	Math. 6a—Analytic Geometry	4
Math. 4 *or* 5—Trigonometry	2	Rhet. 2—Rhetoric and Composition	3
Rhet. 1—Rhetoric and Composition	3	Hygiene	2
Physical Education	1	Physical Education	1
Military Science (for Men)	1	Military Science (for Men)	1
Total	17 or 18	*Total*	19

Curriculum in Aeronautical Engineering

For the Degree of Bachelor of Science in Aeronautical Engineering

First Year

Common Program for Freshmen (page 66)

Second Year

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
G.E.D. 3—Aircraft Drafting and Lofting	2	Math. 9—Integral Calculus	3
Math. 7—Differential Calculus	5	M.E. 82—Machine Tool Production Methods	1
M.E. 81—Pattern, Foundry, and Welding Laboratory	2	Phys. 1b—General Physics	4
Phys. 1a—General Physics	4	Phys. 3b—Physics Laboratory	1
Phys. 3a—Physics Laboratory	1	Speech 1—Prin. of Effective Speaking	3
Non-technical Elective	2	T.A.M. 1—Analyt. Mech. (Statics)	2
Physical Education	1	T.A.M. 2—Analyt. Mech. (Dynamics)	3
Military Science (for Men)	1	Physical Education	1
		Military Science (for Men)	1
Total	18	*Total*	19

Third Year

Aero.E. 1—Aerodynamics	3	Aero.E. 2—Aircraft Materials and Processes	3
Econ. 2—Elements of Economics; *or* Eng. 10—Engineering Economics	3	Aero.E. 22—Aircraft Structures	3
Math. 16—Differential Equations	3	E.E. 18—Electrical Circuits	2
Rhet. 22—Composition (Report Writing)	2	E.E. 68—Electrical Circuits Lab.	1
T.A.M. 3—Resistance of Materials	3	M.E. 13—Thermodynamics	3
T.A.M. 5—Fluid Mechanics	3	M.E. 32—Kinematics and Dynamics of Machinery	3
T.A.M. 63—Res. of Materials Lab.	1	Approved Elective	3
Total	18	*Total*	18

Fourth Year

Aero.E. 23—Aircraft Structures	3	Aero.E. 44—Airplane Design	3
Aero.E. 33—Aircraft Detail Design	2	Aero.E. 62—Aerodynamics Lab.	2
Aero.E. 43—Airplane Design	3	Aero.E. 64—Aircraft Structures Lab.	1
E.E. 19—Aeronautical Electrical Equipment	3	Aero.E. 66—Aircraft Engine Lab.	2
M.E. 9—Internal Combustion Engines	3	Eng. 92—Engineering Law	3
Technical Option[1]	3	Approved Elective	3
Aero.E. 99—Inspection Trip	0	Technical Option[1]	3
Total	17	*Total*	17

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[1] Intended to provide specialized optional sequences in one of several fields in Aeronautical Engineering.

Curriculum in Agricultural Engineering

For the Degree of Bachelor of Science in Agricultural Engineering

First Year

Common Program for Freshmen (page 66)

Second Year

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
Agr.E. 6—Tractors and Field Machinery	3	Agr.E. 3—Farm Structures and Soil and Water Conservation	3
Bot. 5—Botany	3	Agron. 25—Farm Crops	4
Math. 7—Differential Calculus	5	Math. 9—Integral Calculus	3
Phys. 1a—General Physics	4	Phys. 1b—General Physics	4
Phys. 3a—Physics Laboratory	1	Phys. 3b—Physics Laboratory	1
Physical Education	1	T.A.M. 1—Analyt. Mech. (Statics)	2
Military Science (for Men)	1	Physical Education	1
		Military Science (for Men)	1
Total	18	*Total*	19

MACHINERY AND POWER OPTION

Third Year

Econ. 2—Elements of Economics	3	Agr. Econ. 20—Farm Management	3
Geol. 44—Agricultural Geology	3	Agron. 28—Soils	5
M.E. 31—Mechanics of Machinery	5	M.E. 10—Thermodynamics	3
T.A.M. 2—Analyt. Mech. (Dynamics)	3	M.E. 40—Mech. Eng. Design	3
T.A.M. 3—Resistance of Materials	3	M.E. 85—Pattern and Foundry Lab.	3
T.A.M. 63—Res. of Materials Lab.	1		
Total	18	*Total*	17

Fourth Year

Agr.E. 43—Farm Power	3	Agr.E. 44—Design of Agricultural Machinery	3
Agr.E. 99—Inspection Trip	0	Agr.E. 51—Special Problems	3
E.E. 11—D.C. and A.C. Circuits	3	E.E. 12—D.C. and A.C. Apparatus	3
E.E. 61—D.C. and A.C. Laboratory	1	E.E. 62—D.C. and A.C. Laboratory	1
M.E. 41—Mech. Eng. Design	4	M.E. 89—Heat Treatment of Metals	3
M.E. 87—Machine Tool Lab.	3	Approved Elective	5
Approved Elective	3		
Total	17	*Total*	18

STRUCTURES AND SOIL CONSERVATION OPTION

Third Year

C.E. 15—General Surveying	3	Agr. Econ. 20—Farm Management	3
C.E. 35—Plain Concrete	2	Agr.E. 12—Farm Utilities	3
Econ. 2—Elements of Economics	3	Agron. 28—Soils	5
Geol. 44—Agricultural Geology	3	C.E. 61—Structural Stresses	4
T.A.M. 2—Analyt. Mech. (Dynamics)	3	T.A.M. 4—Hydraulics	2
T.A.M. 3—Resistance of Materials	3	T.A.M. 64—Hydraulics Laboratory	1
T.A.M. 63—Res. of Materials Lab	1		
Total	18	*Total*	18

Fourth Year

Agr.E. 42—Hydraulics of Soil and Water Conservation	3	Agr.E. 51—Special Problems	3
Agr.E. 45—Advanced Farm Structures	3	C.E. 64—Structural Design	5
Agr.E. 99—Inspection Trip	0	C.E. 90—Contracts and Specifications	2
C.E.51—Drainage and Flood Control[1]	3	Approved Elective	7
C.E. 62—Structural Analysis	3		
C.E. 63—Structural Design	2		
E.E. 4—D.C. and A.C. Circuits and Machines	2		
E.E. 64—D.C. and A.C. Circuits and Machines Laboratory	1		
Total	17	*Total*	17

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[1] With approval of the head of the department, students interested primarily in structures may substitute a selected course for C.E. 51.

Curriculum in Ceramic Engineering

For the Degree of Bachelor of Science in Ceramic Engineering

First Year

Common Program for Freshmen (page 66), except that Chem. 5 and Math. 10a-10b are substituted for Chem. 4 and Math. 2, 4, and 6a.

Second Year

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
Cer.E. 31—Introd. to Ceramic Eng.	3	Cer.E. 32—Ceramic Processes and Equipment	3
Chem. 23b—Quantitative Analysis	5	Geol. 20—General Mineralogy	3
Math. 8a—Calculus	3	Math. 8b—Calculus	3
Phys. 1a—General Physics	4	Phys. 1b—General Physics	4
Phys. 3a—Physics Laboratory	1	Phys. 3b—Physics Laboratory	1
Physical Education	1	T.A.M. 1—Analyt. Mech. (Statics)	2
Military Science (for Men)	1	Physical Education	1
		Military Science (for Men)	1
Total	18	*Total*	18

Third Year

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
Cer.E. 33—Ceramic Technology	5	Cer.E. 34—Ceramic Technology	5
Cer.E. 35—Principles of Drying	3	Cer.E. 36—Kilns, Furnaces, and Firing Operations	3
Chem. 40—Elementary Physical Chemistry	3	Cer.E. 37—Pyrometry	2
T.A.M. 3—Resistance of Materials	3	Phys. 16—Heat	3
T.A.M. 63—Res. of Materials Lab.	1	Technical Elective	2 or 3
Approved Elective	3	Approved Elective	3
Total	18	*Total*	18 or 19

Fourth Year

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
Cer.E. 38—Dryer and Furnace Design	2	Cer.E. 39—Ceramic Eng. Design	3
Cer.E. 40—Ceramic Bodies and Glazes	5	Cer.E. 41—Refractories	2
E.E. 4—D.C. and A.C. Circuits and Machines	2	E.E. 5—Application of Electrical Equipment	2
E.E. 64—D.C. and A.C. Circuits and Machines Lab.	1	E.E. 65—Electrical Equipment Lab.	1
Technical Elective	5	Technical Elective	5 or 4
Approved Elective	3	Approved Elective	3
Inspection Trip	0		
Total	18	*Total*	16 or 15

Curriculum in Chemical Engineering

For the Degree of Bachelor of Science in Chemical Engineering

This curriculum is administered by the College of Liberal Arts and Sciences.

First Year

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
Chem. 8a—Inorganic Chemistry and Qualitative Analysis[1]	5	Chem. 8b—Inorganic Chemistry and Qualitative Analysis	5
Math. 10a—Freshman Mathematics[2]	5	Math. 10b—Freshman Mathematics	4
German or French	4	German or French	4
Rhet. 1—Rhetoric and Composition	3	Rhet. 2—Rhetoric and Composition	3
Physical Education	1	Hygiene 2 or 5—Hygiene and Sanitation	2
Military Science (for Men)	1	Physical Education	1
		Military Science (for Men)	1
Total	19	*Total*	20

Second Year

Chem. 24—Quantitative Analysis	5	Chem. 34—Organic Chemistry	5
Math. 8a—Differential Calculus	3	Math. 8b—Integral Calculus	3
Phys. 1a—General Physics	4	Phys. 1b—General Physics	4
Phys. 3a—Physics Laboratory	1	Phys. 3b—Physics Laboratory	1
G.E.D. 6—Elements of Drawing	3	T.A.M. 1—Analytical Mechanics	2
Physical Education	1	Physical Education	1
Military Science (for Men)	1	Military Science (for Men)	1
Total	18	*Total*	17

Third Year

Chem. 36—Organic Chemistry	3	Chem. 42—Physical Chemistry	3
Chem. 37—Organic Chemistry Lab.	2	Chem. 63b—Chemical Engineering	3
Chem. 40—Physical Chemistry	3	M.E. 2—Steam Engineering	3
Chem. 41—Physical Chemistry Lab.	1	E.E. 12—Alternating Current Apparatus	3
T.A.M. 3—Resistance of Materials	3	E.E. 62—D.C. and A.C. Lab.	1
T.A.M. 63—Resistance of Mat. Lab.	1	Electives	5
E.E. 11—Direct Current Apparatus	3		
E.E. 61—D.C. and A.C. Lab.	1		
Total	17	*Total*	18

Fourth Year

Chem. 44a—Thermodynamics	2	Chem. 61b—Principles of Chemical Engineering	3
Chem. 60a—Chemical Engineering Unit Processes	3	Chem. 66b—Inspection Trip	½
Chem. 61a—Principles of Chemical Engineering	3	Chem. 68b—Unit Operations Laboratory	2
Chem. 62a—Principles of Research and Development	2	M.E. 61—Mechanical Engineering Laboratory	2
Chem. 66a—Inspection Trip	½	Electives[3]	10
Chem. 68a—Unit Operations Lab.	2		
Chem. 69a—Chemical Engineering Projects Laboratory	2		
Electives[3]	3		
Total	17½	*Total*	17½

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[1] All students with entrance credit in chemistry are required to take a proficiency examination before registering for Chemistry 8a. Those who do not show the necessary proficiency will be placed in Chemistry 1 or 2, after which they will take Chemistry 6 and 10. For students without entrance credit in chemistry, the required sequence is Chemistry 1, 6, and 10.

[2] For students who do not take Math. 10a-10b, the required sequence is Math. 2 (or 3), 4 (or 5), 6 (or 6a), 7, and 9.

[3] Five hours of electives must be in courses for advanced undergraduates in chemistry or chemical engineering, approved by the adviser.

Curriculum in Civil Engineering

For the Degree of Bachelor of Science in Civil Engineering

First Year

Common Program for Freshmen (page 66)

C.E. 1, C.E. 2 and 1 hour of C.E. 3 are required courses which will be taught only at the summer surveying camp following the Freshman Year.

Second Year

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
C.E. 3a—Route Surveying	3	C.E. 35—Plain Concrete	2
C.E. 60—Bridge and Bldg. Constr.	3	C.E. 36—Construction Materials	1
Math. 7—Differential Calculus	5	Geol. 43—Engineering Geology[1]	3
Phys. 1a—General Physics	4	Math. 9—Integral Calculus	3
Phys. 3a—Physics Laboratory	1	Phys. 1b—General Physics	4
Physical Education	1	Phys. 3b—Physics Laboratory	1
Military Science (for Men)	1	T.A.M. 1—Analytical Mech. (Statics)	2
		Physical Education	1
		Military Science (for Men)	1
Total	18	*Total*	18

NOTE: Special third and fourth year curricula are available so that transfer students who have credit in all of the subjects included in the first and second year curricula except C.E. 1, 2, 60 and T.A.M. 1 can complete the requirements for the bachelor's degree in two years if they present an equivalent amount of appropriate credit.

Third Year

C.E. 20—Highways	3	C.E. 62—Structural Analysis	3
C.E. 30—Highway Materials Lab.	1	C.E. 63—Elem. Structural Design	2
C.E. 61—Structural Stresses	4	*M.E. 1—Steam, Air & Gas Machinery	3
E.E. 4 & 64—D.C. and A.C. Circuits and Machines, with Laboratory or Approved Elective	3	T.A.M. 5—Mechanics of Fluids	3
T.A.M. 2—Analyt. Mech. (Dynamics)	3	T.A.M. 65—Fluid Mechanics Lab.	1
T.A.M. 3—Resistance of Materials	3	†Approved Elective	3 or 2
T.A.M. 63—Res. of Mat'ls Lab.	1	‡Non-technical Elective	3
Total	18	*Total*	18 or 17

NOTE: The first three years are the same for all options and the Sanitary Engineering curriculum except as noted below for the sixth semester. These substitutions should be made by the students concerned.

* Replace with M.E. 7 or Aircraft Engines in the Aircraft Structures Option and the Transportation Option.

† Replace with Aero. E. 1 in the Aircraft Structures Option, Math. 9a in the Structural Option, C.E. 90 in the Transportation Option and Chem. 22 (part) in the Sanitary Engineering curriculum.

‡ Replace with Aero. E. 3 in the Aircraft Structures Option and Chem. 22 (part) in the Sanitary Engineering curriculum.

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[1] Eight hours of credit in foreign language (French, German, or Spanish) may be substituted for Geology 43, 3 hours, and approved and non-technical electives, 5 hours.

Fourth Year

GENERAL OPTION

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
C.E. 40—Water Supply	4	C.E. 41—Sewerage	3
C.E. 64—Structural Design	5	C.E. 66—Earth & Masonry Structures	3
C.E. 90—Contracts & Specifications	2	C.E. 94—Professional Practice	0
C.E. 93—Professional Practice	0	Technical Elective	5
C.E. 99—Inspection Trip	0	Approved Elective	3
Technical Elective	3		
Total	14	*Total*	14

AIRCRAFT STRUCTURES OPTION

Aero.E. 24—Adv. Airplane Structures	3	Aero.E. 26—Adv. Airplane Structures	3
C.E. 48—Water Supply & Sewerage	4	Aero.E. 65—Static Testing	2
C.E. 64—Structural Design	5	C.E. 90—Contracts & Specifications	2
C.E. 66—Earth & Masonry Structures	3	C.E. 94—Professional Practice	0
C.E. 93—Professional Practice	0	Electrical Controls	3
C.E. 99—Inspection Trip	0	Approved Elective	3
Total	15	*Total*	13

HYDRAULIC OPTION

C.E. 48—Water Supply & Sewerage	4	C.E. 51—Drainage & Flood Control	3
C.E. 50—Hydrology	3	C.E. 52—Water Resources, Planning and Development	3
C.E. 64—Structural Design	5	C.E. 55—Water Power	3
C.E. 90—Contracts & Specifications	2	C.E. 66—Earth & Masonry Structures	3
C.E. 93—Professional Practice	0	C.E. 94—Professional Practice	0
C.E. 99—Inspection Trip	0	Approved Elective	2
Total	14	*Total*	14

For curriculum in Sanitary Engineering see p. 81.

STRUCTURAL OPTION

C.E. 64—Structural Design	5	C.E. 48—Water Supply & Sewerage	4
C.E. 66—Earth & Masonry Structures	3	C.E. 65—Structural Design	4
C.E. 67—Statically Indet. Struct.	3	C.E. 68—Statically Indet. Struct.	3
C.E. 93—Professional Practice	0	C.E. 90—Contracts & Specifications	2
C.E. 99—Inspection Trip	0	C.E. 91—Estimates and Costs	2
Approved Elective	3	C.E. 94—Professional Practice	0
Total	14	*Total*	15

TRANSPORTATION OPTION

C.E. 64—Structural Design	5	C.E. 24—Airport Design	3
C.E. 66—Earth & Masonry Structures	3	C.E. 48—Water Supply & Sewerage	4
C.E. 93—Professional Practice	0	C.E. 94—Professional Practice	0
C.E. 99—Inspection Trip	0	†Electives	8
*Electives	6		
Total	14	*Total*	15

NOTE: All students registered in the Transportation Option must take at least eight hours in the transportation group of electives below.

* It is recommended that students interested in airway transportation take B.O.O. 50 and C.E. 6; those interested in highway or railway transportation take C.E. 22 and C.E. 27.

† It is recommended that students interested in airway transportation take Geog. 14, Econ. 92 or 95, and approved electives 2 hours; those interested in highway transportation take C.E. 23, C.E. 29, and approved electives 3 hours; and those interested in railway transportation take C.E. 25, C.E. 26 and C.E. 29.

Curriculum in Electrical Engineering

For the Degree of Bachelor of Science in Electrical Engineering

First Year

Common Program for Freshmen (page 66)

Second Year

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
E.E. 14—Wiring and Illumination *or* Approved Elective[1]	3 or 4	E.E. 14—Wiring and Illumination *or* Approved Elective[1]	3 or 4
Math. 7—Differential Calculus	5	Math. 9—Integral Calculus	3
M.E. 85 *or* 87—Pattern and Foundry *or* Machine Tool Laboratory; *or* Approved Elective[1]	3	M.E. 87 *or* 85—Machine Tool *or* Pattern and Foundry Laboratory; *or* Approved Elective[1]	3
Phys. 1a—General Physics	4	Phys. 1b—General Physics	4
Phys. 3a—Physics Laboratory	1	Phys. 3b—Physics Laboratory	1
Physical Education	1	T.A.M. 1—Analytical Mech. (Statics)	2
Military Science (for Men)	1	Physical Education	1
		Military Science (for Men)	1
Total	18 or 19	*Total*	18 or 19

Third Year

E.E. 25—Introd. to Circuit Analysis	4	E.E. 26—Direct Current Apparatus	3
E.E. 75—Electrical Engineering Lab.	2	E.E. 76—Electrical Engineering Lab.	3
Math. 9a—Integral Calculus	2	E.E. 50—Intr. to Applied Electronics	2
M.E. 10—Thermodynamics; *or* Phys. 44—Electrical and Magnetic Measurements	3	M.E. 10—Thermodynamics; *or* Phys. 44—Electrical and Magnetic Measurements	3
T.A.M. 2—Analyt. Mech. (Dynamics)	3	T.A.M. 3—Resistance of Materials	3
T.A.M. 4—Hydraulics	2	T.A.M. 63—Res. of Materials Lab.	1
T.A.M. 64—Hydraulics Laboratory	1	Approved Elective	3
Total	17	*Total*	18

Fourth Year

ELECTRIC POWER

E.E. 35—A.C. Apparatus	4	E.E. 36—A.C. Apparatus	4
E.E. 55—Electrical Design	2	E.E. 56—Economical Design of Electrical Systems	4
E.E. 85—Electrical Engineering Lab.	2	E.E. 86—Electrical Engineering Lab.	2
E.E. 95—Seminar	1	E.E. 96—Seminar	1
E.E. 99—Inspection Trip	0	E.E. 98—Thesis;[2] *or* Technical Elective	3
M.E. 3—Power Plant Engineering	3	Approved Elective	3 or 4
M.E. 61—Mech. Engineering Lab.	2		
Non-technical Elective	3 or 4		
Total	17 or 18	*Total*	17 or 18

ELECTRICAL COMMUNICATIONS

E.E. 35—A.C. Apparatus	4	E.E. 52—Radio Design	3
E.E. 48—Long Line Theory	3	E.E. 53—Ultra High Frequency	4
E.E. 51—Radio Communication	3	E.E. 56—Economical Design of Electrical Systems	4
E.E. 85—Electrical Engineering Lab.	2	E.E. 96—Seminar	1
E.E. 95—Seminar	1	E.E. 98—Thesis;[2] *or* Technical Elective	3
E.E. 99—Inspection Trip	0	Approved Elective	3 or 4
Non-technical Elective	3 or 4		
Total	16 or 17	*Total*	18 or 19

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[1] One semester of E.E. 14 and one semester of M.E. 85 or 87 are required.

[2] Only high-grade students are allowed to take a thesis course.

Curriculum in Engineering Physics

For the Degree of Bachelor of Science in Engineering Physics

The purpose of this curriculum is to prepare students for investigations in engineering problems calling for a knowledge of physics and mathematics or chemistry, and for positions in certain industries which prefer men with a thorough education in basic science. It is also an excellent preparation for graduate work in physics.

Students in the Engineering Physics curriculum, when registering for advanced undergraduate courses in physics at any stage in that curriculum, must have a grade average of at least 3.5 in all subjects, exclusive of the basic courses in military training and physical education, and a combined grade average of at least 3.5 in all subjects in mathematics and physics taken prior to such registration. Transfer students must have a corresponding record in the institution from which they transfer, and must maintain such status at the University of Illinois.

First Year

Common Program for Freshmen (page 66), except
that Chem. 6 is substituted for Chem. 4.

Second Year[1]

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
German *or* Approved Elective	4	German *or* Approved Elective	4
Math. 7—Differential Calculus	5	Math. 9—Integral Calculus	3
Phys. 1a—General Physics	4	Phys. 1b—General Physics	4
Phys. 3a—Physics Laboratory	1	Phys. 3b—Physics Laboratory	1
Physical Education	1	T.A.M. 1—Analytical Mech. (Statics)	2
Military Science (for Men)	1	Physical Education	1
Approved Elective	3	Military Science (for Men)	1
		Approved Elective	3
Total	19	*Total*	19

Third Year[1]

E.E. 25—Introduction to Circuit Analysis	4	Phys. 46a—Vacuum Tubes[4]	3
E.E. 75—Electrical Engineering Lab.	2	Phys. 60—Heat[5]	3
German *or* Approved Elective	4	German *or* Approved Elective	4
Math. 18—Advanced Calculus[2]	3	Math. 19—Advanced Calculus[2]	3
Phys. 20a—Theoretical Mechanics	3	Phys. 20b—Theoretical Mechanics	3
Phys. 40a—Elec. and Magnetism[3]	3	Phys. 40b—Elec. and Magnetism[3]	3
Total	19	*Total*	19

Fourth Year[1]

Chem. 40—Physical Chemistry	3	Phys. 71b—Light	2
Phys. 71a—Light	2	Phys. 72b—Light Laboratory	2
Phys. 72a—Light Laboratory	2	Phys. 199—Colloquium	0
Phys. 80—Atomic Physics; *or* Approved Elective	3	Approved Elective[7]	3
Phys. 46b—Vacuum Tubes[4]	3	Technical Option[6]	8
Phys. 199—Colloquium	0		
Technical Option[6]	3		
Total	16	*Total*	15

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[1] The election of Chemistry 10, 24, and 34 is advised. Students wishing to emphasize chemistry may substitute chemistry electives for E.E. 25, 26, 75, 76. Students wishing to emphasize electrical engineering should elect E.E. 51, 52, 54, and/or 84 in their senior year. Students wishing to emphasize geophysics should elect most or all of the technical options in geology. Five hours must be approved non-technical courses.

[2] Math. 16 and 17 or Math. 71a-71b may be substituted for Math. 18 and 19.

[3] Physics 44 and 30 may be substituted for Physics 40a-40b.

[4] E.E. 50 and 51 may be substituted for Physics 46a-46b.

[5] M.E. 10 or 13 may be substituted for Physics 60.

[6] Technical Options: Chemistry 10, 24, 34, 36, 37, 41, 42, 43, 44; E.E. 26, 48, 51, 52, 53, 54, 76, 84; Geology 2a, 38, 43, 61; Math. 21, 22, 52, 53, 70, 71, 72; M.E. 35, 36, 87; any courses in Physics or Astronomy; T.A.M. 2, 3, 63.

[7] Physics 81 is recommended.

Curriculum in General Engineering

For the Degree of Bachelor of Science in General Engineering

This curriculum is intended for students who do not wish to pursue the more specialized engineering curricula, but who wish to secure a sound education in engineering principles and their application. Fifteen hours work in economics, business law, etc., are required, and twelve hours of free electives are allowed. The mechanical engineering design sequence of courses, namely, M.E. 31, 40, and 41, plus three hours of approved electives will be accepted in place of C.E. 61, 62, 63, and 64 in the junior and senior years. The degree of Bachelor of Science in General Engineering is awarded on completion of the curriculum.

First Year

Common Program for Freshmen (page 66)

Second Year

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
Econ. 2—Principles of Economics	3	Geol. 43—Engineering Geology	3
Math. 7—Differential Calculus	5	Math. 9—Integral Calculus	3
M.E. 85—Pattern and Foundry Lab.; *or* C.E. 15—General Surveying	3	C.E. 15—General Surveying; *or* M.E. 85—Pattern and Foundry Lab.	3
Phys. 1a—General Physics	4	Phys. 1b—General Physics	4
Phys. 3a—Physics Laboratory	1	Phys. 3b—Physics Laboratory	1
Physical Education	1	T.A.M. 1—Analytical Mech. (Statics)	2
Military Science (for Men)	1	Physical Education	1
		Military Science (for Men)	1
Total	18	*Total*	18

Third Year

Econ. 35—Corporations	3	C.E. 61—Structural Stresses	4
E.E. 11—D.C. and A.C. Circuits	3	E.E. 12—D.C. and A.C. Apparatus	3
E.E. 61—D.C. and A.C. Laboratory	1	E.E. 62—D.C. and A.C. Laboratory	1
M.E. 87—Machine Tool Laboratory	3	M.E. 10—Thermodynamics	3
T.A.M. 2—Analyt. Mech. (Dynamics)	3	T.A.M. 4—Hydraulics	2
T.A.M. 3—Resistance of Materials	3	T.A.M. 64—Hydraulics Laboratory	1
T.A.M. 63—Res. of Materials Lab.	1	Approved Elective[1]	4
Total	17	*Total*	18

Fourth Year

C.E. 62—Structural Analysis	3	C.E. 64—Structural Design	5
C.E. 63—Structural Design	2	Econ. 3—Money, Credit, Banking	3
C.E. 99—Inspection Trip	0	Eng. 92—Engineering Law	3
Econ. 41—Labor Problems; *or* Eng. 39—Industrial Relations	3	M.E. 64—Mechanical Engineering Laboratory	3
M.E. 3—Power Plant Engineering	3	Approved Elective[1]	4
Met.E. 1—Elements of Metallurgy	3		
Approved Elective[1]	4		
Total	18	*Total*	18

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[1] Eight hours or more in a foreign language (French, German, or Spanish) may be substituted for an equal number of hours of approved electives.

Curriculum in Mechanical Engineering

For the Degree of Bachelor of Science in Mechanical Engineering

First Year

Common Program for Freshmen (page 66)

Second Year

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
Approved Elective[1]	3	Approved Elective[1]	4
Math. 7—Differential Calculus	5	Math. 9—Integral Calculus	3
M.E. 85—Pattern and Foundry Lab.; *or* M.E. 87—Machine Tool Lab.	3	M.E. 87—Machine Tool Lab.; *or* M.E. 85—Pattern and Foundry Lab.	3
Phys. 1a—General Physics	4	Phys. 1b—General Physics	4
Phys. 3a—Physics Laboratory	1	Phys. 3b—Physics Laboratory	1
Physical Education	1	T.A.M. 1—Analytical Mech. (Statics)	2
Military Science (for Men)	1	Physical Education	1
		Military Science (for Men)	1
Total	18	*Total*	19

Third Year

M.E. 13—Thermodynamics	3	M.E. 6—Power Plant Equipment	4
M.E. 31—Mechanics of Machinery	5	M.E. 14—Thermodynamics	3
T.A.M. 2—Analyt. Mech. (Dynamics)	3	M.E. 40—Mech. Engineering Design	3
T.A.M. 3—Resistance of Materials	3	M.E. 64—Mech. Engineering Lab.	3
T.A.M. 63—Res. of Materials Lab.	1	M.E. 88—Machine Tool Laboratory	3
Non-technical Elective[2]	3	Non-technical Elective[2]	2
Total	18	*Total*	18

Fourth Year

E.E. 11—D.C. and A.C. Circuits	3	E.E. 12—D.C. and A.C. Apparatus	3
E.E. 61—D.C. and A.C. Laboratory	1	E.E. 62—D.C. and A.C. Laboratory	1
M.E. 41—Mech. Eng. Design	4	M.E. 28—Heating, Ventilating, and Air Conditioning	4
M.E. 65—Mech. Engineering Lab.	3	M.E. 52—Power Plant Design	3
M.E. 89—Heat Treatment of Metals; *or* Non-technical Elective[2]	3	M.E. 89—Heat Treatment of Metals; *or* Non-technical Elective[2]	3
Technical Option	3	Technical Option	3
M.E. 99—Inspection Trip	0		
Total	17	*Total*	17

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[1] Eight hours or more in a foreign language (French, German, or Spanish) may be substituted for an equal number of hours of approved electives.

[2] Special attention is called to Engineering 10, 20, 39, 40, 41, and 92.

OPTIONS FOR THE CURRICULUM IN MECHANICAL ENGINEERING

NOTE: Curriculum options are groups of related courses which can be logically taken together and thus emphasize certain subdivisions, or fields, of mechanical engineering.

PETROLEUM PRODUCTION ENGINEERING

Substitute in Mechanical Engineering Curriculum as follows:

Second Year

Geol. 43 for Approved Elective	3	Geol. 2a for Approved Elective	4

Third Year

C.E. 15 for Non-technical Elective	3

Fourth Year

M.E. 35, T.A.M. 4 and 64, and Geol. 61a for M.E. 41 and Technical Option	9	M.E. 36, Geol. 60b, and Geol. 61b for M.E. 28 and 52 and Technical Option	8

RAILWAY MECHANICAL ENGINEERING

Substitute in Mechanical Engineering Curriculum as follows:

Fourth Year

M.E. 5 for Technical Option	3	M.E. 8 for Technical Option	3
		M.E. 54 for M.E. 52	3

TECHNICAL OPTIONS IN MECHANICAL ENGINEERING

Fourth Year

M.E. 5—Locomotives	3	M.E. 7—Int. Combustion Engines	3
M.E. 7—Int. Combustion Engines	3	M.E. 8—Railway Operation	3
M.E. 17—Refrigeration Engineering	3	M.E. 15—Engineering Thermodynamics	3
M.E. 35—Petroleum Production Eng.	3	M.E. 17—Refrigeration Engineering	3
M.E. 42—Analytical Design of High-speed Engines	3	M.E. 36—Petroleum Production Eng.	3
M.E. 84—Welding Engineering	3	M.E. 54—Locomotive and Car Design	3
T.A.M. 4 and 64—Hydraulics	3	M.E. 84—Welding Engineering	3
T.A.M. 41—Advanced Mechanics	3	T.A.M. 4 and 64—Hydraulics	3
T.A.M. 43—Hydraulics Laboratory	3	T.A.M. 42—Engineering Materials	3
T.A.M. 44—Testing Materials	3	T.A.M. 43—Hydraulics Laboratory	3
T.A.M. 47—Engineering Analysis	3	T.A.M. 44—Testing Materials	3
T.A.M. 49—Advanced Dynamics and Vibrations	3	T.A.M. 48—Engineering Analysis	3
C.E. 89—Structural Engineering	3	T.A.M. 50—Advanced Dynamics and Vibrations	3

Curriculum in Metallurgical Engineering

For the Degree of Bachelor of Science in Metallurgical Engineering

This curriculum is intended for the training of industrial metallurgists and those who wish to engage in advanced study and research, either in operational processes or in various problems involving physical and chemical phases of metallurgy.

First Year

Common Program for Freshmen (page 66), except that Chem. 5 and Math. 10a-10b are substituted for Chem. 4 and Math. 2, 4, 6a.

Second Year

FIRST SEMESTER	HOURS
Chem. 23a—Quantitative Analysis	5
Math. 8a—Differential Calculus	3
Phys. 1a—General Physics	4
Phys. 3a—General Physics Laboratory	1
Physical Education	1
Military Science (for Men)	1
Approved Elective	3 or 4
Total	18 or 19

SECOND SEMESTER	HOURS
Math. 8b—Integral Calculus	3
Phys. 1b—General Physics	4
Phys. 3b—Physics Laboratory	1
Met.E. 1—Introduction to Metallurgy	3
T.A.M. 1—Analyt. Mech. (Statics)	2
Physical Education	1
Military Science (for Men)	1
Approved Elective	3 or 4
Total	18 or 19

Third Year

Chem. 48a—Physical Chemistry	3
Met.E. 10—Principles of Physical Metallurgy	4
Met.E. 11—Metallurgy of Iron and Steel	3
Met.E. 12—Metallurgical Calculations	2
Cer.E. 37—Pyrometry	2
Approved Elective	3
Total	17

Chem. 48b—Physical Chemistry	3
Met.E. 13—Metallography and Heat Treatment of Iron and Steel	3
Met.E. 14—Ferrous Metallography Lab.	2
Met.E. 16—Non-Ferrous Production Metallurgy	3
T.A.M. 3—Resistance of Materials	3
T.A.M. 63—Res. of Materials Lab.	1
Approved Elective	3
Total	18

Fourth Year

E.E. 4—A.C. and D.C. Circuits and Machines	2
E.E. 64—A.C. and D.C. Circuits and Machines Lab.	1
Met.E. 20—Non-Ferrous Metallography	3
Met.E. 21—Non-Ferrous Metallography Lab.	2
Met.E. 22—Electrometallurgy	3
Met.E. 90—Seminar	1
T.A.M. 44—Advanced Lab. in Testing Materials	3
Met.E. 99—Inspection Trip	0
Approved Elective	3
Total	18

E.E. 5—Applications of Electrical Equipment	2
E.E. 65—Applications of Electrical Equipment Lab.	1
Met.E. 23—Metallurgy of Deep Drawing and Pressing	3
Met.E. 24—Alloy Steels	3
Met.E. 26—Advanced Physical Metallurgy Lab.	3
Met.E. 91—Seminar	1
Approved Elective	5
Total	18

Curriculum in Mining Engineering

For the Degree of Bachelor of Science in Mining Engineering

First Year

Common Program for Freshmen (page 66)

Second Year

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
Geol. 43—Engineering Geology	3	Geol. 20—General Mineralogy	3
Math. 7—Calculus	5	Math. 9—Calculus	3
Min.E. 1—Elements of Mining	4	Min.E. 2—Mining Methods	4
Phys. 1a—General Physics	4	Phys. 1b—General Physics	4
Phys. 3a—Physics Laboratory	1	Phys. 3b—Physics Laboratory	1
Physical Education	1	T.A.M. 1—Analytical Mechanics (Statics)	2
Military Science (for Men)	1	Physical Education	1
		Military Science (for Men)	1
Total	19	*Total*	19

Third Year

C.E. 15—General Surveying	3	Econ. 41—Introduction to Labor Problems; *or* Econ. 43—Personnel Admin.; *or* Advanced Military	3
Econ. 2—Elements of Econ.; *or* Advanced Military	3	Geology Elective	2 or 3
Min.E. 10—Haulage, Hoisting, and Pumping	4	M.E. 62—Mech. Eng. Lab.	3
T.A.M. 2—Analytical Mechanics (Dynamics)	3	Min.E. 11—Mine Ventilation	2
T.A.M. 4—Hydraulics	2	Min.E. 12—Mine Surveying	2
T.A.M. 64—Hydraulics Lab.	1	T.A.M. 3—Resistance of Materials	3
		T.A.M. 63—Res. of Materials Lab.	1
Total	16	*Total*	16 or 17

SUMMER

First Week

Min.E. 61—First Aid and Mine Rescue........................1 hour

Second and Third Weeks

Min.E. 62—Summer Mine Surveying........................2 hours

Fourth Year

C.E. 89—Structural Engineering; *or* M.E. 87—Machine Tool Lab.	3	E.E. 12—Direct and Alternating Current Apparatus	3
E.E. 11—Direct and Alternating Current Circuits	3	E.E. 62—Direct and Alternating Current Lab.	1
E.E. 61—Direct and Alternating Current Lab.	1	Met.E. 1—Elements of Metallurgy	3
Min.E. 20—Mine Administration	3	Min.E. 23—Examination and Valuation	2
Min.E. 21—Mineral Dressing	3	Min.E. 24—Mining Design	3
Min.E. 22—Fuels	3	Min.E. 25—Coal Preparation	2
Min.E. 99—Inspection Trip	0	Approved Elective	3 or 4
Total	16	*Total*	17 or 18

Curriculum in Public Health Engineering[1]

For the Degree of Bachelor of Science in Public Health Engineering

First Four Years

The first four years are the same as the Sanitary Option in Civil Engineering or the Sanitary Engineering curriculum. Students who have received the bachelor's degree in sanitary engineering or its equivalent at a recognized college of engineering are admitted to the fifth year in this curriculum providing they have had the necessary prerequisites for the particular courses required at the University of Illinois. The work for the first semester of the fifth year is offered at Urbana, and the second half of the year is offered at the College of Medicine in Chicago.

Fifth Year

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
Chem. 47—Physical Chemistry	4	C.E. 190—Public Health Engineering	3
Chem. 86a—Chemistry of Water Treatment	3	P.H. 1—Bact. and Protozoology	6
C.E. 45—Public Health Engineering	3	P.H. 4—Preventive Medicine	2
Zool. 1—General Zoology	4	P.H. 12—Industrial Hygiene	1
Approved Electives (D.H. 10; Entom. 2; Math. 22; M.E. 25)	5	P.H. 50—Public Health	1
		P.H. 73—Advanced Public Health	2
		Pharmacology *or* Approved Elective	3
Total	19	*Total*	18

Curriculum in Sanitary Engineering[1]

For the Degree of Bachelor of Science in Sanitary Engineering

First Three Years

The first three years are the same as the Curriculum in Civil Engineering except that the substitutions shown on page 72 should be made in the sixth semester.

Fourth Year

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
Bact. 5a—Introd. Bacteriology	3	Chem. 33—Elem. Organic Chemistry	5
C.E. 40—Water Supply	4	C.E. 41—Sewerage	3
C.E. 45—Public Health Engineering	3	C.E. 44—Water & Sewage Treatment	3
C.E. 64—Structural Design	5	C.E. 66—Earth & Masonry Srructures	3
C.E. 93—Professional Practice	0	C.E. 94—Professional Practice	0
C.E. 99—Inspection Trip	0		
Total	15	*Total*	14

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[1] Administered by the Department of Civil Engineering.

COURSES OFFERED IN THE COLLEGE OF ENGINEERING

THE FOLLOWING LIST OF COURSES offered in the College of Engineering is arranged alphabetically by names of departments. Names of staff members in each department (as of July, 1946) are listed by rank and by seniority of appointment within each rank, except the head of the department who is listed first. (For complete names, with degrees and titles, see page 5.) The courses offered by each department are listed numerically in groups with headings to indicate the students for whom they are designed. The description of each course shows its content or purpose, the terms during which it is offered, and its credit value. Terms of the year are represented by symbols: "I" for the first semester, and "II" for the second semester. Courses extending through both semesters are designated as "continuous through I and II."

Credit for undergraduate students is counted in *semester hours.* A semester hour represents the work of one classroom period of fifty minutes each week through one semester, or the equivalent in laboratory, shop, or drafting room. In descriptions of courses the credit values are shown in parentheses: for example, "(3)" meaning three hours of credit each semester.

Credit for graduate students is counted in *units.* A unit course requires approximately ten hours of time each week through one semester. Four such courses constitute a student's normal program for a semester. In descriptions of courses for graduates the unit values per semester are stated in parentheses.

Prior to the beginning of each semester, the University publishes a *Time Table* listing all courses offered by the departments at Urbana, and showing the time and place of meeting of classes. Each student is supplied with a copy of the *Time Table* when he registers. Some courses are given also in the summer sessions, and a special pamphlet announcing them is issued in the spring of each year.

AERONAUTICAL ENGINEERING

Associate Professors: STILLWELL (Head of the Department), KRZYWOBLOCKI.
Assistant Professors: MCCLOY, JOHNSON.
Instructors: SEAGRIST.
Cooperating: Assistant Professor J. G. CLARK and Assistant Professor W. E. HANSON.

Courses for Undergraduates

1. AERODYNAMICS.—Fundamentals of aerodynamics as applied to the airplane and other means of flight. Propeller selection, classical performance analysis, and principles of airplane stability. I and II, (3). *Prerequisite:* T.A.M. 1.
2. AIRCRAFT MATERIALS AND PROCESSES.—Physical and chemical properties of materials used in aircraft construction. Thermal and chemical treatments of aircraft materials. Forming and fabrication. I and II, (3). *Prerequisite:* M.E. 81 and 82; T.A.M. 3; Aero. E. 1.

3. Aircraft Construction.—A study of the purpose and operation of aircraft parts, accessories, and assemblies. I and II, (3). *Prerequisite:* Sophomore standing in engineering and consent of instructor.

11. Aerodynamics.—Special performance problems, seaplanes and flying boats, principles of airplane stability and control extended, flight testing for performance. I and II, (3). *Prerequisite:* Aero. E. 1.

12. Airplane Propellers.—Propeller blade action theory, aerodynamic propeller testing, blade design and stress analysis, effect of the propeller on airplane performance. I and II, (2). *Prerequisite:* Aero. E. 1; T.A.M. 3.

22. Aircraft Structures.—Structural analysis as applied to aircraft. Analysis of beams, columns, trusses, connections, and frames. Allowable stresses. I and II, (3). *Prerequisite:* T.A.M. 3 and 63; Aero. E. 1.

23. Aircraft Structures.—Continuation of Aero. E. 22. Buckling of plates. Bending and torsion analysis of single and multi-cell shell structures. Analysis of tension field beams and beam columns. I and II, (3). *Prerequisite:* Aero. E. 22; Math. 16.

24. Advanced Aircraft Structures.—Structural theory and design of aircraft; analysis of unsymmetrical sections, multiple cell structures with thin skin in bending and torsion and stiffened flat and curved sheets; combined stresses; deflection of beams and trusses. I and II, (3). *Prerequisite:* C.E. 62 and 63.

25. Advanced Aircraft Structures.—Analysis of trussed structures, space structures, and unsymmetrical sections; influence lines; deflections by graphical analysis; non-circular members in torsion. I and II, (3). *Prerequisite:* Aero. E. 23.

26. Advanced Aircraft Structures.—Analysis of semi-tension field beams, beam columns, closed frames, curved beams and indeterminate trusses; column analogy and moment distribution. I and II, (3). *Prerequisite:* Aero. E. 24 or 25.

33. Aircraft Detail Design.—Layout and design of simple aircraft components. Installation, assembly and detail drawings. Standards and specification. I and II, (2). *Prerequisite:* G.E.D. 3; Aero. E. 22; M.E. 32.

34. Aircraft Component Design.—Design and analysis of aircraft hydraulic, electrical, pneumatic, mechanical, de-icing, and heating systems. I and II, (3). *Prerequisite:* M.E. 32; E.E. 18.

43. Airplane Design.—Preliminary design of the airplane primarily from the aerodynamic standpoint. Planning through to the three-view layout. Weight and balance calculation, performance estimation, stability, and load determination. I and II, (3). *Prerequisite:* T.A.M. 2; Aero. E. 22.

44. Airplane Design.—Airworthiness requirements, stress analysis procedure, and design of the airplane structure. I and II, (3). *Prerequisite:* Aero. E. 2, 23, and 43.

51. Aircraft Power Plants.—A study of current engines and their construction, supercharging, performance, carburetion, ignition, cooling, engine installation, jet-propulsion engines, and rocket power plants. I and II, (3). *Prerequisite:* Junior standing in engineering.

52. Fuels, Lubricants and Combustion.—Fuel specifications and tests, lubricants and lubrication, kinetics of flames and combustion. I and II, (2). *Prerequisite:* Chem. 4; junior standing in engineering.

53. Aircraft Internal Combustion Engine Design.—Internal combustion engine design applied to aircraft engines. I and II, (3). *Prerequisite:* M.E. 9; Aero. E. 22; consent of instructor.

62. Aerodynamics Laboratory.—Experimental aerodynamics illustrating basic principles. Use and calibration of instruments. Measurement of airflow. Pressure distribution. Wind tunnel tests of aircraft components and complete model airplane. I and II, (2). *Prerequisite:* T.A.M. 5; Aero. E. 43.

64. Aircraft Structures Laboratory.—Physical testing of aircraft components and assemblies; use and calibration of strain and deflection measuring devices; design of fixtures used for testing. I and II, (1). *Prerequisite:* Aero. E. 23.

65. Aircraft Physical Testing.—Physical testing of structural members and assemblies; use and calibration of strain and deflection measuring devices; design of fixtures used for testing. I and II, (2). *Prerequisite:* Aero. E. 24.

90. Special Problems.—Special problems relating to the theory, design, testing, operation, maintenance, or production of airframes or aircraft power plants. I and II, (2 to 4). *Prerequisite:* Senior standing in engineering and consent of the instructor.

99. Inspection Trip.—Visit to airplane manufacturing plants and research institutions. I, (no credit). *Prerequisite:* Senior standing.

CERAMIC ENGINEERING

Professors: Andrews (Head of the Department), Parmelee (*Emeritus*), Hursh.
Associate Professors: Cook.
Instructors: Allen, Fitzpatrick.

Courses for Undergraduates

31. Introduction to Ceramic Engineering.—Raw materials, classification and characteristics of ceramic products, and methods of manufacture. I, (3).

32. Ceramic Processes and Equipment.—Sources, preparation of materials, and manufacturing processes and control. II, (3).

33. Ceramic Technology.—Physical and chemical properties and reactions of ceramic materials and mixtures. I, (5). *Prerequisite:* Junior standing.

34. Ceramic Technology.—Continuation of Cer. E. 33. II, (5). *Prerequisite:* Cer. E. 33.

35. Principles of Drying.—Drying, drying equipment, and construction and regulation of dryers. I, (3). *Prerequisite:* Credit or registration in Cer. E. 33.

36. Kilns, Furnaces, and Firing Operations.—The firing process, utilization of fuels, types of kilns and furnaces and their operation. II, (3). *Prerequisite:* Credit or registration in Cer. E. 34.

37. Pyrometry.—Principles and methods used in high temperature measurement. I and II, (2). *Prerequisite:* Junior standing.

38. Ceramic Engineering Design.—Design of ceramic dryers, kilns, and furnaces. I, (2). *Prerequisite:* T.A.M. 3; Cer. E. 35 and 36.

39. Ceramic Engineering Design.—Design of special ceramic equipment, factory planning and layout. II, (3). *Prerequisite:* T.A.M. 3; Cer. E. 35, 36, and 38.

40. Ceramic Bodies and Glazes.—Materials, compositions, processing, properties, and tests. I, (5). *Prerequisite:* Cer. E. 34.

41. Refractories.—Composition and properties of refractory materials and products, their manufacture and use. II, (2). *Prerequisite:* Cer. E. 34 and 36.

42. Ceramic Microscopy.—The application of microscopic methods for the study of ceramic materials, reactions and products. II, (3). *Prerequisite:* Geol. 6.

43. Cements, Limes, and Plasters.—Compositions, reactions, method of manufacture, and testing. I, (2). *Prerequisite:* Cer. E. 33 and 34.

44. Elementary Glass Technology.—Preparation of glasses of various compositions, measurement of properties, and methods of melting and forming used in industry. II, (3). *Prerequisite:* Junior standing.

45. Advanced Glass Technology.—Constitution and physical and chemical properties of glasses. I, (2). *Prerequisite:* Senior standing.

46. Porcelain Enamels.—Compositions, preparation, application, properties, and tests. II, (4). *Prerequisite:* Registration in Cer. E. 34.

96. Research Methods.—Procedures and planning of investigations in ceramic research. I or II, (1 to 3). *Prerequisite:* Senior standing in ceramic engineering.

98. Thesis.—Research on a selected subject. I or II, (1 to 3). *Prerequisite:* Cer. E. 96 and consent of Head of the Department.

99. Inspection Trip.—Visit to industrial plants. I, (no credit). *Prerequisite:* Senior standing.

Courses for Graduates

NOTE:—This department offers graduate work leading to the degrees of Master of Science in Ceramics, Master of Science in Ceramic Engineering, Doctor of Philosophy in Ceramics, and Doctor of Philosophy in Engineering.

Candidates for the degree of Doctor of Philosophy in Ceramics must have had the equivalent of at least 25 semester hours of satisfactory courses in general, analytical, physical, and organic chemistry; also calculus, one year of college physics, one semester of optical mineralogy, and at least 18 semester hours or their equivalent in acceptable ceramic courses.

110. Ceramic Chemistry.—Silica, silicates, fusions, and phase relations. I, (*1 unit*). *Prerequisite:* Courses in chemistry and physics. Professor Andrews.

111. Ceramics.—Chemical and physical phenomena. II, (*1 to 2 units*). Laboratory if taken for two units. *Prerequisite:* Courses in chemistry and physics. Professor Andrews.

112. Drying.—I or II, (*1 to 2 units*). Laboratory if taken for two units. *Prerequisite:* Cer. E. 35 or equivalent. Professor Hursh.

113. Porcelain Enamels.—I or II, (*1 to 2 units*). Laboratory if taken for two units. *Prerequisite:* Cer. E. 46 or equivalent. Professor Andrews, Associate Professor Cook.

114. Firing.—I or II, (*1 to 2 units*). Laboratory if taken for two units. *Prerequisite:* Cer. E. 36 or equivalent. Professor Hursh.

115. Glass.—I or II, (*1 to 2 units*). Laboratory if taken for two units. *Prerequisite:* Cer. E. 44 or equivalent.

116. Refractories.—I or II, (*1 to 2 units*). Laboratory if taken for two units. *Prerequisite:* Cer. E. 41 or equivalent. Professor Hursh.

117. Special Ceramic Bodies or Glazes.—I or II, (*1 to 2 units*). Laboratory if taken for two units. *Prerequisite:* Cer. E. 40 or equivalent.

118. Materials and Special Problems.—I or II, (*1 to 2 units*). Conference and laboratory. Professors Andrews and Hursh, Associate Professor Cook.

190. Research.—I and II, (*1 to 4 units*). Candidates for the Master of Science or Doctor of Philosophy degree may elect research in any of the branches of ceramics. Arrange. Professors Andrews and Hursh, Associate Professor Cook.

CIVIL ENGINEERING

Professors: Huntington (Head of the Department), King (*Emeritus*), Wilson, Babbitt, Crandell, Doland, Shedd, Vawter, Wiley, Newmark.
Associate Professors: Rayner, Oliver.
Assistant Professors: Bauer, Dell, Peck, Clark, Hanson, Schmidt.
Associates: Thornburn.
Lecturers: Cummings, Wisely, Randall, Terzaghi.

Courses for Undergraduates

1. Plane Surveying.—Use and care of instruments; practice in the common field methods of measuring distance, angles, and elevation; computations of areas and volumes; land survey and re-survey methods; legal principles; problems. At summer camp only, (3). *Prerequisite:* G.E.D. 1 or 4; Math. 4.

2. Topographic Surveying.—Contours, map construction and volumetric estimates from contour maps; astronomical determination of latitude and azimuth; transit-stadia methods of topographic surveying; survey and map of an assigned area. At summer camp only, (3). *Prerequisite:* C.E. 1.

3a. Route Surveying.—Horizontal and vertical alinement for railways and highways; grades and grade reduction; curves, turnouts, and earthwork, principles of economic location; surveys, plans, and estimates. I and II, (3). *Prerequisite:* C.E. 2, 15, or 18.

3b. ROUTE SURVEYING.—One hour of C.E. 3 to be taken concurrently with C.E. 3a or at preceding summer camp.

6. PHOTOGRAMMETRY.—Principles of perspective and stereoscopic vision; characteristics of aircraft and cameras for mapping work; photographic scales and displaced images; plotting map control from photographers by slotted templets; transferring photographic data by tracing and by projectors; drawing a topographic map from photographs using (a) a linear scale and (b) the stereocomparograph, the multiplex projector and other photogrammetric instruments. I, (3). *Prerequisite:* C.E. 2.

15. GENERAL SURVEYING.—Use and care of surveying instruments; computations of areas and volumes; transit-stadia mapping methods; contour problems. For students in other departments. I and II, (3). *Prerequisite:* G.E.D. 1 or 4; Math. 4.

17. SURVEYING FOR LANDSCAPE ARCHITECTS.—Field problems; use of instruments, notekeeping, signals, basic surveying operations; office problems. I, (3). *Prerequisite:* Sophomore standing in landscape architecture.

18. SURVEYING FOR LANDSCAPE ARCHITECTS.—Use and construction of contour maps; methods of mapping; computation of earthwork; office problems; actual surveys. II, (3). *Prerequisite:* C.E. 17.

19. CONSTRUCTION SURVEYING.—Principles of surveying as applied to construction work on bridges, buildings, tunnels, sewers, etc. II, (3). *Prerequisite:* C.E. 3; Math. 7.

20. HIGHWAYS.—Soils, drainage, and materials of construction for roads and pavements; construction of earth, gravel, and macadam roads; city and rural pavement construction, repairs and maintenance; accessories; resurfacing; width and capacity of roads and streets; estimates. I and II, (3). *Prerequisite:* C.E. 2, 15, 18, or consent of instructor.

22. HIGHWAY AND MUNICIPAL DESIGN.—Road systems, city streets, pavement types; design, preparation of plans, specifications, and estimates of cost. I, (4). *Prerequisite:* C.E. 20, or consent of instructor.

23. TRAFFIC ENGINEERING.—Characteristics of highway traffic; vehicle dimensions and weights; speeds and speed limits; traffic surveys, types, methods, interpretations; traffic control devices, motor vehicle and traffic laws; enforcement; safety. II, (3). *Prerequisite:* C.E. 20 or consent of instructor.

24. AIRPORT DESIGN.—Requirements of site; arrangement of various facilities; location, soil studies, grading, drainage, and surfacing of runways; general features of hangars, shops, and other buildings. I, (3). *Prerequisite:* Senior standing in engineering or architecture.

25. RAILWAY CONSTRUCTION AND MAINTENANCE.—Earthwork and rockwork; track materials; track stresses; and track design. II, (3). *Prerequisite:* C.E. 3.

26. RAILWAY LOCATION AND OPERATION.—Influence of volume of traffic, alinement, and gradient upon operating expenses. II, (3). *Prerequisite:* C.E. 3.

27. TERMINALS.—Design and operation of railway yards, freight terminals and passenger stations. Bus and truck terminals and stations. I, (2). *Prerequisite:* C.E. 3 or consent of instructor.

29. SIGNALS.—Railway block and route signaling; automatic train control; interlocking; track circuits; signal equipment. Highway fixed cycle and traffic actuated signals. II, (2). *Prerequisite:* C.E. 3 and 20, senior standing, or consent of instructor.

30. HIGHWAY MATERIALS LABORATORY.—Laboratory practice in testing of asphalts, tars, road oils, bituminous mixtures, stone, gravel, and paving brick. I and II, (1). *Prerequisite:* Junior standing in engineering, architecture, or landscape architecture.

31. ADVANCED HIGHWAY MATERIALS.—Advanced work in the examination and testing of bituminous materials and mixtures, Portland cement concrete, and soils for engineering purposes. Each student selects one material for special study. II, (2). *Prerequisite:* C.E. 30, 32, or 35.

32. ENGINEERING PROPERTIES OF SOILS.—Origin, formation, development, classification, identification, and characteristics of soils; engineering soil surveys; sampling; compaction of embankments; frost action; and laboratory practice in testing of soils. I or II, (2). *Prerequisite:* Senior standing in engineering, or consent of instructor.

35. Plain Concrete.—Tests for Portland cement; aggregates; field and laboratory examination and tests; proportioning. Laboratory practice. I and II, (2). *Prerequisite:* Sophomore standing in engineering, architecture, or landscape architecture.

36. Construction Materials.—Manufacture, properties, and use of cast iron, wrought iron, steel and other metals, brick and terra cotta; formation, properties, and use of stone; growth, properties, and use of timber. This course supplements Civil Engineering 30, 31, and 35. I and II, (1). *Prerequisite:* Sophomore standing in engineering, architecture, or landscape architecture.

40. Water Supply.—Finances, hydraulics, demands, sources, reservoirs, pipe lines, pumping machinery, materials, distribution systems. I and II, (4). *Prerequisite:* T.A.M. 3, 4, and 64; M.E. 1.

41. Sewerage.—Sewerage systems, surveys and plants, hydraulics, house sewerage, rainfall and storm-water flow, size and capacity of sewers, appurtenances, estimates and specifications, construction. I and II, (3). *Prerequisite:* T.A.M. 4 and 64.

44. Water and Sewage Treatment.—Principles, design, and operation of water purification and sewage treatment works. II, (3). *Prerequisite:* Bact. 5a; registration or credit in C.E. 41.

45. Public Health Engineering.—Principles of sanitation, waste collections and disposal, sanitary regulations, biostatistics. I, (4). *Prerequisite:* Registration or credit in Bact. 5a and Chem. 22.

48. Water Supply and Sewerage.—Development, design, construction, and maintenance of municipal water works and sewerage works not including water purification or sewage treatment. I and II, (4). *Prerequisite:* T.A.M. 4 and 64, or 5 and 65.

50. Hydrology.—Precipitation, evaporation, transpiration, deep seepage, run-off, hydraulics of rivers and small streams; use of current meter, float, weir, etc. I, (3). *Prerequisite:* Senior standing in engineering.

51. Drainage and Flood Control.—Land drainage, river improvement, flood control. II, (3). *Prerequisite:* C.E. 50.

52. Water Resources, Planning and Development.—Purposes and techniques of planning water resources developments; methods of evaluating the engineering and economic aspects of water conservation projects developed through the examination of actual proposals. II, (3). *Prerequisite:* Registration or credit in C.E. 50.

55. Water Power.—Rainfall and stream flow records; estimate of available power; theory and testing of turbines; dams, power house, approach channels, draft tubes; relation of investment costs, auxiliary plants, and other factors to the value of projects. II, (3). *Prerequisite:* T.A.M. 4 and 64.

60. Bridge and Building Construction.—Materials, types of construction, and details for bridges and buildings. I and II, (3). *Prerequisite:* Sophomore standing.

61. Structural Stresses.—Analysis of stresses in statically determinate structures. I and II, (4). *Prerequisite:* Registration or credit in T.A.M. 3.

62. Structural Analysis.—An introduction to statically indeterminate structures. I and II, (3). *Prerequisite:* T.A.M. 3; C.E. 61.

63. Elementary Structural Design.—An introduction to structural design; design of flexural members in steel, concrete, and timber. I and II, (2). *Prerequisite:* T.A.M. 3; registration or credit in C.E. 61.

64. Structural Design.—Theory of design and design of structures of steel, concrete, and timber. I and II, (5). *Prerequisite:* C.E. 62 and 63.

65. Structural Design.—An extension of C.E. 64, devoted principally to bridges. I and II, (4). *Prerequisite:* C.E. 64.

66. Earth and Masonry Structures.—Dams, retaining walls, bridge piers and abutments, and foundations. I and II, (3). *Prerequisite:* C.E. 61 and 63.

67. Statically Indeterminate Structures.—Elastic theory and its applications to statically indeterminate structures. I, (3). *Prerequisite:* Registration or credit in C.E. 64. C.E. 67 is recommended for graduate students who have not had similar training.

68. Statically Indeterminate Structures.—Continuation of C.E. 67. II, (3). *Prerequisite:* C.E. 67 or C.E. 62 and consent of instructor.

89. Structural Engineering.—Design of steel, reinforced concrete, and timber structures. For students in other departments. I, (3). *Prerequisite:* Senior standing in engineering or architecture.

90. Contracts and Specifications.—Engineering relations; the law of contracts; business and technical clauses used in specifications. I and II, (2). *Prerequisite:* Senior standing in engineering or architecture.

91. Estimates and Costs.—Economic selection; construction cost estimating; direct and overhead costs; cost keeping; construction by force account and contract; time schedules and progress charts; valuation. I and II, (2). *Prerequisite:* Senior standing in engineering or architecture.

93-94. Professional Practice.—A series of lectures by distinguished engineers on various phases of civil engineering professional practice. Lectures will be given on alternate weeks. I and II, (0). *Prerequisite:* Senior standing in civil engineering.

95-96. Special Problems.—Individual investigations or studies of any phase of civil engineering selected by the students. I and II, (1 to 3). *Prerequisite:* Senior standing in civil engineering.

97-98. Thesis.—Investigation or design. May be substituted for certain technical subjects in any of the five options of the senior year. Continuous through I and II, (1 to 3). *Prerequisite:* Senior standing; consent of Head of Department.

99. Inspection Trip.—I, (no credit). *Prerequisite:* Senior standing.

Courses for Graduates

120a. Highway Engineering.—Highway transportation, airport design, street layouts, regional plans, and pavements for cities. I, (*1 unit*). Professor Crandell.

123. Highway Traffic, Transport, and Safety.—Traffic growth, characteristics, surveys, regulations, and signaling; private and commercial transportation by automobile, bus, and truck; transportation organization and regulation; accident surveys, analysis, and prevention. I and II, (*1 unit*). Professor Wiley.

124. Airport Design.—Requirements of site; arrangement of various facilities; location, soil studies, grading, drainage, and surfacing of runways; general features of hangars, shops, and other buildings. I and II, (*1 unit*). Professors Crandell, Doland, and Shedd, Assistant Professor Peck.

125. Railway Location and Operation.—Railway location; track capacity; tonnage ratings. I and II, (*1 unit*). Professor Wiley.

135. Municipal Engineering.—City finances and budgets, the work of the city manager and city engineer, zoning, playgrounds and parks, street cleaning, smoke prevention, and fire prevention. II, (*1 unit*). Professor Crandell.

140a. Water Supply.—Design, pumping machinery, administration, operation. I, (*1 unit*). Professor Babbitt.

143. Sewerage.—Sewer design, construction, maintenance, operation, and financing. II, (*1 unit*). Professor Babbitt.

144. Sewage Disposal, Wastes Disposal, and General Sanitation.—Principles and design of sewage treatment and waste disposal works. II, (*1 unit*). Professor Babbitt.

146. Public Health Engineering.—Design of water purification works and principles of sanitation. I, (*1 unit*). Professor Babbitt.

148. Sanitary Engineering Laboratory.—Tests of water supply, sewerage, water purification and sewage treatment equipment and processes. I and II, (*1 to 2 units*). Professor Babbitt.

150. Hydrology and Flood Control.—Magnitude and frequency of flood flow of streams, minimum flow of streams and regulation of flow by storage reservoirs, intense rainfall and the development of intensity curves for use in rational run-off formula, unit-graph method of computing flood run-off, flood control and prevention by channel improvement, levees, and reservoirs. I and II, (*1 unit*). Professor Doland.

152. Water Resources Planning and Development.—Purposes and techniques of planning water resources developments; methods of evaluating the engineering and economic aspects of water conservation projects developed through the examination of actual proposals. II, (*1 unit*). Professor Doland.

155. Water Power.—Preliminary investigations, selection of site, storage requirements, structures, machinery, etc. II, (*1 unit*). Professor Doland.

161. Structural Theory and Design.—General theory of continuity; moment distribution; the column analogy; rigid frame bridges and buildings; fixed and continuous arches; classification of structures from viewpoint of design. I, (*1 or 2 units*). Professors Shedd and Vawter.

162. Structural Theory and Design.—Statically indeterminate trusses; continuous trusses; steel arches; secondary stresses; suspension bridges; long-span roofs; skeleton steel buildings. II, (*1 to 2 units*). Professors Shedd and Vawter.

164. Reinforced Concrete Design.—Theories of action of beams, slabs, and columns of reinforced concrete; codes and specifications and their influence on design; effect of continuity. I, (*1 unit*). Professor Shedd.

165. Steel Design.—Design of steel members; codes and specifications for buildings; riveted and welded connections; evolution of bridge specifications; loads and working stresses; economic proportions. II, (*1 unit*). Professor Shedd.

169. Wood Structures.—Theory and practice in the design of modern wood structures; the effect of the plant origin and physical structure of wood on its mechanical strength; fasteners and their significance in design and the development of design formulae. I, (*1 unit*). Associate Professor Oliver.

170. Earth and Masonry Structures.—Design and construction of dams, retaining walls, abutments and piers, culverts, grain elevators and bins. I, (*1 unit*). Professor Huntington.

173. Soil Mechanics.—Physical properties of soils; identification and description of soils; permeability, compressibility, consolidation, and shearing resistance; deformation and drainage characteristics. Theories of soil mechanics; earth pressure, stability, settlement, seepage, and consolidation. I, (*1 unit*). Assistant Professors Peck and Bauer, Dr. Terzaghi, Mr. Cummings.

174. Soil Mechanics.—Practical considerations; boring, sampling, testing; retaining walls, open cuts, slides, dams and embankments; foundations, settlements due to excavation and other causes; field observations. Limitations and alternatives to conventional procedures of design and construction. Further study in any phase of this course can be pursued under C.E. 190. II, (*1 unit*). Assistant Professor Peck, Dr. Terzaghi, Mr. Cummings.

181. Advanced Structural Analysis — Approximate Methods.—Methods of successive approximations and numerical procedures for the solution of complex problems, with applications to bridges, buildings, and aircraft structures. Method of successive relaxation of constraints, energy methods, difference equations, numerical integration procedures, method of collocation, method of least squares, and Galerkin's method. I and II, (*1 to 2 units*). Professor Newmark.

182. Advanced Structural Analysis — Buckling, Vibrations, and Impact.—Elastic and inelastic instability of bars, plates, and plates with stiffeners. Vibrations of structures including earthquake effects. Action of simple structural elements and of more complex structures subjected to dynamic loads, with applications to bridges, buildings, and aircraft structures. I and II, (*1 to 2 units*). Professor Newmark.

185. Analytical Study of Tests of Structural Steel Members.—Planning tests, limitations of experimental methods, interpretation of results in terms of design practice. II, (*1 unit*). Professor Wilson.

186. Advanced Analysis and Design of Aircraft Structures.—Analysis and design of frames and individual members of aircraft structures. I and II, (*1 to 2 units*). Assistant Professor Clark.

190. Special Problems.—Individual investigations or studies of any phase of civil engineering selected by the student. I and II, (*½ to 2 units*). Members of the department.

198. Thesis.—I and II, (*1 to 2½ units*). Members of the department.

ELECTRICAL ENGINEERING

Professors: Everitt (Head of the Department), Brooks (*Emeritus*), Paine (*Emeritus*), Tykociner (*Emeritus*), Knight, Kraehenbuehl, Keener, Samuel.
Associate Professors: Reid, Tuthill, Waldo (*Emeritus*), Faucett, Jordan, Archer, Fett, Hayward, Skroder, DeVore, Honnell.
Assistant Professors: Helm, Horn, Peirce, Bennett.
Instructors: Bailey, Miller, Schwarzlose, Scott.

Courses for Undergraduates

4. Direct and Alternating Current Circuits and Machines.—Fundamental principles of electrical circuits and machines. For students in agricultural, ceramic, civil, and mining engineering. I and II, (2). *Prerequisite:* Phys. 1a, 1b, 3a, 3b; Math. 8b or 9; registration in E.E. 64.

5. Applications of Electrical Equipment.—Applications of electricity for industrial uses. For students in ceramic and mining engineering. I and II, (2). *Prerequisite:* E.E. 4, 64; registration in E.E. 65.

11. Direct and Alternating Current Circuits.—Fundamental electric and magnetic units and circuits, direct and alternating currents. For students in agricultural, chemical, general, and mechanical engineering, and industrial administration. I and II, (3). *Prerequisite:* Phys. 1a, 1b, 3a, 3b; Math. 8b or 9; registration in E.E. 61.

12. Direct and Alternating Current Apparatus.—Generators and motors, transformers, rectifiers, and electronic devices. I and II, (3). *Prerequisite:* E.E. 11, 61; registration in E.E. 62.

14. Wiring and Illumination.—Fundamentals of commercial and industrial wiring and illumination practice. I and II, (3). Not open to students with credit in E.E. 90. *Prerequisite:* Sophomore standing.

25. Introduction to Circuit Analysis.—Electric and magnetic units and circuits; graphical and mathematical treatment of periodic current circuits; special problems in alternating current networks; electrostatic circuits; wave analysis. I and II, (4). *Prerequisite:* Phys. 1b, 3b; Math. 9; registration in Math. 9a or 16; registration in E.E. 75.

26. Direct Current Apparatus.—Theory and characteristics of direct current apparatus. I and II, (3). *Prerequisite:* E.E. 25; Math. 9a; registration in E.E. 76.

35. Alternating Current Apparatus.—Transformers and generators. I and II, (4). *Prerequisite:* E.E. 26, 76; registration in E.E. 85.

36. Alternating Current Apparatus.—Synchronous, induction, and commutator motors; rotary converters, distributed inductance and capacity, transient phenomena. I and II, (4). *Prerequisite:* E.E. 35; registration in E.E. 86.

41. Transit Engineering Principles.—Railway mechanics, power systems and control. I, (5). *Prerequisite:* E.E. 26, 76.

42. Transit Engineering Practice.—Electric railway locomotives, cars, and auxiliary equipment, railway electrification. II, (4). *Prerequisite:* E.E. 41.

44. Transit Engineering Laboratory and Design.—Tests of electrical railway machinery, test cars, design of an electric rail line, selection of equipment. II, (3). *Prerequisite:* Registration in E.E. 42.

46. Transit Engineering.—For students in engineering departments other than Electrical. Transportation methods and requirements. II, (3). *Prerequisite:* E.E. 4, 11, or 25 and 64, 61, or 75.

48. Theory of Long Lines and Electrical Networks.—Fundamentals of telephone networks and transmission lines, loading, filters, reflections, inductive interference, and superimposed circuits. I and II, (3). *Prerequisite:* Senior standing in electrical engineering, or consent of instructor.

50. Introduction to Applied Electronics.—Fundamental principles of the design, operation, and application of electron devices. I and II, (2). *Prerequisite:* E.E. 25.

51. Radio Communication Apparatus.—Fundamentals of circuits of and phenomena in radio communication apparatus. Measurement of radio frequency circuit parameters, wave propagation, performance of transmitters and receivers. I and II, (3). *Prerequisite:* E.E. 25, 50, or equivalent.

52. Radio Engineering Design.—Fundamentals of design of radio transmitters, transmission lines, antennas, and receivers. Laboratory measurements associated with design. I and II, (3). *Prerequisite:* E.E. 51, or equivalent.

53. Ultra-High-Frequency Techniques.—Theory, characteristics, and operation of klystron, magnetron, and other decimeter-wave generators, antenna arrays, wave propagation, wave guides, radiation from parabolas and horns, impedance matching, modulation, detection, and reception of decimeter waves. I and II, (4). *Prerequisite:* Registration in E.E. 48 and 52. Registration in E.E. 59 and 89 is desirable.

54. Vacuum Tubes and Control Devices.—Theory, characteristics, and application of the high vacuum tubes, amplifiers, and control devices. I, (3). *Prerequisite:* E.E. 25, 50.

55. Electrical Design.—Electromagnets and dynamos, direct and alternating, transformers. I and II, (2). *Prerequisite:* E.E. 26; registration in E.E. 35.

56. Economical Design of Electrical Systems.—Power plants, distribution, etc. I and II, (4). *Prerequisite:* E.E. 35.

57. Electrical Energy Measurements and System Protection.—Theory and application of power and energy measuring equipment. Protection of transmission and distribution systems. II, (3). *Prerequisite:* Senior standing in electrical engineering, or consent of instructor.

58. Power Transmission and Distribution Circuits.—Transient behavior of lumped constant circuits by differential equation methods and by Heavisides expansion theorem; development general network theorems; steady state solution with distributed constants; system stability analysis. I, (3). *Prerequisite:* E.E. 25.

59. Electron Tubes.—Theory, characteristics, and applications of glow and arc discharge tubes, photocells, electronic control devices, rectifiers, oscillators, and inverters. II, (3). *Prerequisite:* E.E. 54, or consent of instructor.

61. Direct and Alternating Current Laboratory.—Circuits. For students in agricultural, chemical, general, and mechanical engineering, and industrial administration. I and II, (1). *Prerequisite:* Registration in E.E. 11.

62. Direct and Alternating Current Laboratory.—Machines. For students in agricultural, chemical, and general engineering, and industrial administration. I and II, (1). *Prerequisite:* E.E. 11, 61; registration in E.E. 12.

64. Direct and Alternating Circuits and Machines Laboratory.—To accompany Electrical Engineering 4. For students in agricultural, ceramic, civil, and mining engineering. I and II, (1). *Prerequisite:* Registration in E.E. 4.

65. Electrical Equipment Laboratory.—I and II, (1). *Prerequisite:* Registration in E.E. 5.

71-72. Electrical Engineering Problems.—I and II, (1 to 3). *Prerequisite:* Approval of written application to department. Members of the department.

75. Electrical Engineering Laboratory.—Direct and alternating current circuits and instruments. I and II, (2). *Prerequisite:* Registration in E.E. 25.

76. Electrical Engineering Laboratory.—Operation and testing of direct current machines. I and II, (3). *Prerequisite:* E.E. 25, 75; registration in E.E. 26.

84. Vacuum Tube Laboratory.—Experimental study of the characteristics and applications of high vacuum tubes. I, (1). *Prerequisite:* Registration in E.E. 54, or consent of instructor.

85. Electrical Engineering Laboratory.—Advanced alternating current laboratory. I and II, (2). *Prerequisite:* E.E. 76; registration in E.E. 35.

86. Electrical Engineering Laboratory.—Advanced alternating current laboratory. I and II, (2). *Prerequisite:* E.E. 85; registration in E.E. 36.

89. Electron Tube Laboratory.—Experimental study of glow and arc discharge tubes and photocells and their applications to power control. II, (1). *Prerequisite:* Registration in E.E. 59, or consent of instructor.

90. Building Lighting.—I and II, (1). Not open to students with credit in Electrical Engineering 14. *Prerequisite:* Junior standing.

95-96. Seminar.—Papers and discussions of current engineering topics. I and II, (1) *Prerequisite:* Senior standing in electrical engineering.

97-98. Thesis.—First semester, preliminary reading and investigation; second semester, completion. Continuous through I and II, (0 to 3).

99. Inspection Trip.—I, (no credit). *Prerequisite:* Senior standing.

Courses for Graduates

(The separate courses under the general numbers 101, 102,
103, and 104 may be taken simultaneously)

101a. Graduate Seminar.—Required of all graduate students. (No credit). Professor Everitt.

101. Advanced Courses in Alternating Currents.—(*½ to 2 units*).
    (b) Circuit Transients.—Professor Knight.
    (c) Machine Transients.—Professor Keener.
    (d) Symmetrical Components.—Professor Kraehenbuehl.
    (e) Advanced Communication Networks.—Associate Professor Skroder.
    (f) Advanced Alternating Current Machinery.—Professor Keener.

102. Waves, Generation and Utilization.—(*½ to 2 units*).
    (a) Electromagnetic Fields and Radiating Systems.—Associate Professor Jordan.
    (b) Electroacoustical Systems.—Professor Everitt.

103. Electric Design.—(*1 to 3 units*).
    (a) Power Plant Design.—Associate Professor Archer.
    (b) Machine Design.—Associate Professor Archer.
    (c) Illumination Practice and Design.—Professor Kraehenbuehl.
    (d) Power Transmission Systems.—Associate Professor Faucett.
    (e) Principles of Servo-Mechanisms and Automatic Control Devices.—Associate Professor Fett.

104. Vacuum Tubes and Electronic Control.—(*1 unit*).
    (a) Theoretical Electronics.—Associate Professor Fett.
    (b) Vacuum Tube Circuit Analysis.—Professor Everitt.
    (c) Photoelectric Cells, Control Tubes and Inverters.—Associate Professor Fett.

105. Electrical Engineering Research.—(*1 to 3 units*). Professors Everitt, Tykociner, Knight, Kraehenbuehl, and Keener, Associate Professors Faucett, Archer, Skroder, Fett, and Jordan.

ENGINEERING

Professors: Jordan, Casberg, Crandell, Draffin, Young.
Associate Professors: Tuthill.

Courses for Undergraduates

NOTE:—Each of the following courses may be used as an approved or non-technical elective in all engineering curricula.

10. Engineering Economics.—Evolution and growth of industry; basic industrial principles; ownership and securities; standardization; valuation and depreciation; comparisons and selections of engineering projects. I and II, (3). *Prerequisite:* Sophomore standing in engineering.

20. History of Engineering.—Important elements in the growth of the art and science of engineering from ancient times to the present. Lives of some of the men who

have been leaders. Effect of engineering on social conditions of various periods. I and II, (2). *Prerequisite:* Junior standing in engineering.

39. Industrial Relations.—History of the development of industry; the factory system; manufacturers' organizations; labor organizations; works management; wage systems; personnel problems; labor legislation. I and II, (3). *Prerequisite:* Junior standing.

40. Transportation Development.—Transportation systems; history and technical development of city transit systems, and of rail, highway, waterway, and air transport; organization and interrelation. I and II, (2). *Prerequisite:* Sophomore standing.

41. Transportation Problems.—Continuation of Engineering 40. Regulation of transportation systems, technical, operating, and financial, by government bodies; government vs. private ownership and operation; technical and economic problems of transport systems. I and II, (3). *Prerequisite:* Eng. 40, or senior standing in engineering.

92. Engineering Law.—Contracts, evidence, torts, equity, real property, corporations, agency, sales, negotiable instruments, water rights, patent rights, special assessments, contract letting, general conditions. I and II, (3). *Prerequisite:* Senior standing in engineering or architecture.

GENERAL ENGINEERING DRAWING

Professors: Jordan (Head of the Department), Hoelscher, Springer.
Associate Professors: Porter, Hall, Jorgensen.
Assistant Professors: Walker, Pierce.
Associates: Crossman.
Instructors: Larson, Pearson, Starr, Shook, Wilson, Sandberg.
Assistants: Shick.

Courses for Undergraduates

1. Elements of Drawing.—Lettering; orthographic projection; working drawings; chart and diagram drawing; isometric and oblique drawing; freehand sketching; tracings; methods of reproducing drawings. I and II, (4). Seniors receive only three hours credit. *Prerequisite:* Plane geometry.

2. Descriptive Geometry.—Theory of projections; solution of theoretical and practical problems involving size, shape, and relative position of common geometrical magnitudes such as points, lines, planes, curved surfaces, and solids; intersections, developments, shades and shadows, perspective drawing, etc. I and II, (4). *Prerequisite:* Plane and solid geometry.

3. Aircraft Drafting and Lofting.—Aircraft terminology, control and reference surfaces and systems. Sheet metal terminology and fabrication. Drafting standards and types of drawings. Drafting room manuals and standard handbooks. Descriptive geometry applied to simple layouts and details. Aircraft fastenings. Lofting—plane, tapered, and double cornered surfaces, airfoils, intersections. Practices and standards incidental to the foregoing considerations. I and II, (2). *Prerequisite:* G.E.D. 1 or 4, and 2.

4. Advanced Drawing.—Review of orthographic projection and working drawings; isometric, oblique, chart and diagram, topographical, architectural, and structural drawing. I and II, (4). *Prerequisite:* Three years of high school drawing, or the equivalent to be determined by the department.

6. Elements of Drawing.—Same topics covered as in General Engineering Drawing 1 plus piping and perspective drawing. For students in chemical engineering. I and II, (3). *Prerequisite:* Plane geometry.

7. Architectural Projections.—Instrumentation; lettering; projection; intersections; conventions; shades and shadows; oblique, isometric, and perspective drawing. I, (2). *Prerequisite:* Plane and solid geometry.

8. Architectural Projections (Continued).—Shades and shadows; oblique, isometric, and perspective drawing; developments. I and II, (2). *Prerequisite:* G.E.D. 7.

10. Pictorial Drawing.—Mechanical and freehand drawings in axonometric, oblique and perspective; shades and shadows; rendering of drawings with various

media including some work with the airbrush; industrial production illustration. An approved elective in all engineering curricula. I and II, (3). *Prerequisite:* G.E.D. 2.

12. Graphical Calculations.—Construction and uses of nomographs, coordinate papers (principally logarithmic and semi-logarithmic), various types of slide rules, and mechanical calculating devices; other methods of engineering calculations. An approved elective in all curricula of the college. I and II, (1). *Prerequisite:* G.E.D. 1; Math. 6a.

MECHANICAL ENGINEERING

Professors: Parker (Head of the Department), Leutwiler (*Emeritus*), Kratz (*Emeritus*), Young, Ham, Polson (*Emeritus*), Casberg, Macintire, Severns, Espy, Ryan, Konzo, Fellows, Trigger.
Associate Professors: Riddell (*Emeritus*), Larson, Schubert.
Assistant Professors: Broghamer, Krans, Miles, Doyle, Martin.
Associates: Hall (*Emeritus*), Starr, Seyfarth, Cole, Greffe, Henry.
Instructors: Wright, Luke, Derrough, Singer, Weber, Bayne.

Courses for Undergraduates

1. Steam, Air, and Gas Machinery.—Theory, construction, operating characteristics of boilers, prime movers, air compressors, and auxiliaries. For civil engineering students. I and II, (3). *Prerequisite:* Math. 9; Phys. 1 and 3.

2. Steam Engineering.—Thermodynamic properties of working mediums, transformation of heat to work, theoretical and practical limitations; the second law, absolute temperature, available energy; power cycles, ideal and practical; energy equations of steady flow; power equipment and auxiliaries. For chemical engineering students. I and II, (3). *Prerequisite:* Math. 9 or 8b; Phys. 1 and 3.

3. Power Plant Engineering.—Steam generators, prime movers, and auxiliaries, for central stations. For electrical and general engineering students. II, (3). *Prerequisite:* M.E. 10; registration in M.E. 61.

5. Locomotives.—Steam and other motive power; mechanics; thermal analysis. I, (3). *Prerequisite:* T.A.M. 1; registration in M.E. 13 and T.A.M. 2.

6. Power Plant Equipment.—An introductory study of the functions and characteristics of equipment; including steam generators, prime movers, condensers, pumps, air compressors, fans, chimneys, feed water treatment, and auxiliaries. For mechanical engineering students. I and II, (4). *Prerequisite:* Registration in M.E. 14.

7. Internal Combustion Engines.—Theory, performance, and general characteristics. I and II, (3). *Prerequisite:* M.E. 6 or 3.

8. Railway Operation.—Train resistance; mechanics of train movements; locomotive economy and performance; shops and terminal facilities. I, (3). *Prerequisite:* M.E. 5.

10. Thermodynamics.—Transformation of heat to work, theoretical and practical limitations, absolute scale of temperature and its significance, thermodynamic properties of working media, energy equation of steady flow, analysis of ideal power and refrigeration cycles. For electrical or general engineering students. I and II, (3). *Prerequisite:* Math. 9; Phys. 1 and 3.

13. Thermodynamics.—Transformations of energy, theoretical limitations; second law, absolute temperature, entropy and available energy; properties of gases, liquids, vapors, and vapor mixtures. I and II, (3). *Prerequisite:* Math. 9; Phys. 1 and 3.

14. Thermodynamics.—Energy relations of one-dimensional steady flow of compressible fluids applied to the De Laval nozzle, simple orifice, and long pipe; simple single-stage impulse turbine; ideal power cycles; thermodynamics and processes of moist air; and other applications. I and II, (3). *Prerequisite:* M.E. 13.

15. Engineering Thermodynamics.—Application of principles of thermodynamics to selected problems of power production, heat transfer, fluid flow of a compressible medium, cycle analysis. II, (3). *Prerequisite:* M.E. 14.

17. Refrigeration Engineering.—Mechanical cooling in industrial processes. I and II, (3). *Prerequisite:* M.E. 14.

21. Mechanical Equipment of Buildings.—Laboratory tests of steam engines, turbines, pumps, hot-blast heaters, fans, air washers, heating boilers, and air compressors. I, (1). *Prerequisite:* Senior standing; registration in M.E. 23.

23. Mechanical Equipment of Buildings.—Small power plants, direct and indirect heating, ventilation, and air conditioning. I, (4). *Prerequisite:* Senior standing; registration in M.E. 21.

25. Heating and Ventilation for Architects.—Direct and indirect heating, ventilation and air analysis, air conditioning. I, (2). *Prerequisite:* Senior standing.

28. Heating, Ventilating, and Air Conditioning.—Steam boilers and water heaters, direct and indirect heating, gravity systems, district heating, ventilation and air analysis, air conditioning. II, (4). *Prerequisite:* M.E. 14 and 65.

31. Mechanics of Machinery.—Cams, gears, graphical construction; kinetics; balancing; critical speeds; force and mass reduction. I and II, (5). *Prerequisite:* Registration in T.A.M. 2.

35. Petroleum Production Engineering.—Development: properties of petroleum, petroleum reservoirs, exploration methods, field development, drilling, oil field hydrology, oil well completion. I, (3). *Prerequisite:* Senior standing in mechanical engineering, or consent of instructor.

36. Petroleum Production Engineering.—Production methods: reservoir drainage, controlled flowing, gas lift, pumping, repressuring, water drive, natural gasoline, storage, transportation. II, (3). *Prerequisite:* M.E. 35, or consent of instructor.

40. Mechanical Engineering Design.—Design of machinery subjected to heavy and variable stresses. I and II, (3). *Prerequisite:* T.A.M. 3 and 63; M.E. 31.

41. Mechanical Engineering Design.—Continuation of course 40. I and II, (4). *Prerequisite:* M.E. 40.

42. Analytical Design of High-speed Engines.—Study of the dynamics of high-speed internal-combustion engine, engine balance, crankshaft deflections, and torsional vibrations. I and II, (3). *Prerequisite:* M.E. 31; senior standing or consent of instructor.

52. Power Plant Design.—Study and design of some form of modern steam power plant. I and II, (3). *Prerequisite:* M.E. 65.

54. Locomotive and Car Design.—Motive power and rolling stock selection; standards and proportions. II, (3). *Prerequisite:* Registration in M.E. 8.

61. Mechanical Engineering Laboratory.—Tests of prime movers and auxiliaries. For chemical and electrical engineering students. I and II, (2). *Prerequisite:* M.E. 1, 2, or 3.

62. Mechanical Engineering Laboratory.—Steam boilers and auxiliaries, steam prime movers, pumps, condensers, fans, air compressors and internal combustion engines. Lectures, recitations, and laboratory. I, (3). Students who have credit in M.E. 1, 2, or 3 may register for one hour of laboratory work only. *Prerequisite:* Junior standing.

64. Mechanical Engineering Laboratory.—Instruments and tests of steam prime movers, pumps, fans, internal combustion engines, and flow of compressible media. Engineering reports. I and II, (3). *Prerequisite:* Registration in M.E. 6 and 14, or 3.

65. Mechanical Engineering Laboratory.—Tests of air conditioning equipment, reciprocating steam pumps, air compressors, and other power and mechanical equipment selected by the students. Engineering reports. I and II, (3). *Prerequisite:* M.E. 64.

81. Pattern, Foundry, and Welding Laboratory.—Design of patterns, molding, coremaking, metallurgical considerations; fundamentals of welding; application to design; selection of materials and equipment; fabrication; and inspection. I and II, (1). *Prerequisite:* Sophomore standing; G.E.D. 1.

82. Machine Tool Production Methods.—Operation and function of lathes, planers, milling machines, turret lathes, and gear cutting machines in the production of interchangeable parts; the use of jigs and fixtures in quantity production to

reduce cost and insure interchangeable parts. I and II, (2). *Prerequisite:* Sophomore standing; G.E.D. 1.

84. Welding Engineering.—Welding processes; metallurgy, metallography, physical tests, and inspection of welds; design of weldments; application to the design and production of machines and structures. I and II, (3). *Prerequisite:* Senior standing in engineering; consent of instructor.

85. Pattern and Foundry Laboratory.—Design of wood and metal patterns; metallurgy of gray iron; floor, bench, and machine molding; core making; brass furnace and cupola practice; sand testing. I and II, (3). *Prerequisite:* Sophomore standing; G.E.D. 1 or 4.

87. Machine Tool Laboratory.—Machine tools; fixtures, jigs, and tools for producing interchangeable parts. I and II, (3). *Prerequisite:* Sophomore standing.

88. Machine Tool Laboratory.—Experiments on machine tool performance, tool and fixture design, shop management and production problems. I and II, (3). *Prerequisite:* M.E. 87; junior standing.

89. Heat Treatment of Metals.—Heat treatment and metallurgy of steels and nonferrous alloys; heat treating operations and study of microstructure and physical properties; hardenability, grain size testing, and machinability; heat treating operations as applied in production. I and II, (3). *Prerequisite:* Senior standing in mechanical engineering.

97-98. Thesis.—Investigation of special subjects and preparation of thesis embodying review of the literature, discussion of results. I and II, (3). *Prerequisite:* Senior standing.

99. Inspection Trip.—I, (no credit). *Prerequisite:* Senior standing.

Courses for Graduates

NOTE:—The prerequisite for graduate work in mechanical engineering is the equivalent of the undergraduate course required for a bachelor's degree in mechanical engineering in the branch of the subject in which registration is desired.

107. Thermodynamics.—Mathematics of thermodynamics; application of thermodynamics to the solution of physical and engineering problems. I and II, (*1 unit*).

108. Flow of Fluids and Heat Transfer.—Application of dimensional analysis and other rational formulas. Special problems. I and II, (*1 unit*). Professor Macintire.

109. Mechanical Engineering Design.—Machine design, power plant design, dynamics of machinery. I and II, (*1 unit*). Professor Ham.

110. Advanced Heating, Ventilating, and Air Conditioning.—Applications of various systems, notable developments, and results of research. Individual problems. I and II, (*1 unit*). Professors Parker and Fellows.

112. Laboratory Investigations.—Special problems in: (a) combustion; (b) steam; (c) gas and oil engineering; (d) heating, ventilating, and air conditioning; (e) refrigeration; (f) flow of fluids; (g) heat transfer; (h) mechanical transmission of power; (i) railway equipment. I and II, (*1½ units*). Professor Parker.

117. Advanced Refrigeration Engineering.—Advanced theory and special cycles; design of comfort cooling and other special installations. I and II, (*1 unit*). Professor Macintire.

120. Locomotive Design.—Economic and legal considerations; specifications; weight and distribution; relation of steam pressure, compounding, and superheat to performance and economy. I and II, (*1 unit*).

121. Locomotive Operation.—Train resistance and locomotive tractive force; tonnage ratings. I and II, (*1 unit*). Professor Young.

MINING AND METALLURGICAL ENGINEERING

Professors: Walker (Head of the Department).
Assistant Professors: Bruckner, Forsyth, Stewart, Eckel, Ricketts, Clark.
Assistants: Bohl.

MINING

Courses for Undergraduates

1. Elements of Mining.—Explosives, drilling, blasting, tunneling, shaft sinking. I, (4). *Prerequisite:* Sophomore standing in mining engineering.

2. Mining Methods.—Methods of working bedded, vein, and placer deposits; mechanized mining. II, (4). *Prerequisite:* Min. E. 1.

10. Haulage, Hoisting, and Pumping.—Haulage: cars, locomotives, track; hoisting: ropes, cages and skips, hoisting engines; mine drainage and pumping. I, (4). *Prerequisite:* Min. E. 2.

11. Mine Ventilation.—Mine gases; ventilation of mines; mine fires and explosions. II, (2). *Prerequisite:* Min. E. 2.

12. Mine Surveying.—Methods of underground surveying. II, (2). *Prerequisite:* C.E. 15 or equivalent.

20. Mine Administration.—Mining law, wage agreements, compensation, safety, and welfare. I, (3). *Prerequisite:* Senior standing in mining engineering.

21. Mineral Dressing.—Crushing, grinding, sampling, screening, classification, and concentration of ores, including flotation; flow sheets. I, (3). *Prerequisite:* Junior standing in mining or metallurgical engineering.

22. Fuels.—Coal classification and utilization, laboratory work in fuel analysis. I, (3). *Prerequisite:* Chem. 4 or equivalent.

23. Examination and Valuation.—Methods of examining, valuing and reporting on mining properties. II, (2). *Prerequisite:* Min. E. 2.

24. Mining Design.—Student selects a project, such as design of headframe, shop building, shaft bottom, etc. II, (3). *Prerequisite:* Senior standing in mining engineering.

25. Coal Preparation.—Mechanical preparation of coal, float and sink testing, washability curves, laboratory control. II, (2). *Prerequisite:* Min. E. 21 and 22.

30. Mining Principles.—Explosives and blasting, rock and well drilling, shaft sinking and tunneling, methods of working flat and inclined deposits. For students in curricula other than mining engineering. II, (3). *Prerequisite:* Sophomore standing.

61. First Aid and Mine Rescue.—One week spent at a State Rescue Station. Credit granted upon securing certificate. II, (1). *Prerequisite:* Registration in mining engineering.

62. Summer Mine Surveying.—Two weeks practice in underground surveying in an Illinois coal mine. II, (2). *Prerequisite:* Min. E. 12.

99. Inspection Trip.—I, (no credit). *Prerequisite:* Senior standing.

Courses for Graduates

NOTE:—The prerequisite for graduate work with mining engineering as a major is the equivalent of the undergraduate courses required for a bachelor's degree in mining engineering. Courses for advanced undergraduates are open for minor credit to students whose major is in other departments, who have adequate preparation in physics, mathematics, and mechanics.

101. Research in Mining Engineering and Mineral Dressing.—I and II, (*1 to 2 units*).

102. Advanced Mineral Dressing and Coal Preparation.—I, (*1 unit*).

104. Mine Valuation, Taxation, and Mineral Economics.—II, (*1 unit*).

105. Advanced Mine Administration.—II, (*1 unit*).

METALLURGY

Courses for Undergraduates

1. Introduction to Metallurgy.—An introduction to metallurgical processes designed to give a survey of the entire field of metallurgy and serve as a background for more advanced courses. II, (3).

3. Fire Assaying.—Fire assay of ores, mattes, and bullion for gold, silver, lead, and copper; fluxes, slags, and charge calculations. I, (3).

10. Principles of Physical Metallurgy.—Constitutional diagrams; homogeneous and heterogeneous equilibria; properties of metals and alloys as related to structure; elementary physics of metals; problems. I, (4). *Prerequisite:* Credit or registration in Chem. 48a.

11. Metallurgy of Iron and Steel.—Production of pig iron, wrought iron, and steel; blast, Bessemer, open hearth, and electric furnaces; iron ores and slags; problems. I, (3). *Prerequisite:* Chem. 2 or 3; registration in Met. E. 12.

12. Metallurgical Calculations.—Fundamental calculations relating to combustion of fuel, thermochemistry and thermophysics, furnace charges and products, and heat balances in metallurgical processes. I, (2). *Prerequisite:* Registration in Chem. 48a or equivalent.

13. Metallography and Heat Treatment of Iron and Steel.—Internal structure, constitution, heat treatment, physical and mechanical properties of commercial iron, wrought iron, cast iron, malleable iron, and plain carbon steels. II, (3). *Prerequisite:* Met. E. 10; credit or registration in T.A.M. 3 and 63; credit in Met. E. 11 is recommended.

14. Ferrous Metallography Laboratory.—Preparation of metallographic specimens and development of microscopic structures; use of metallurgical microscope; photomicrography; interpretation of structures developed by heat treatment and mechanical working of iron and steel alloys. Laboratory to accompany Met. E. 13. II, (2). *Prerequisite:* Registration in Met. E. 13.

15. Metallurgical Fuels and Furnaces.—Metallurgical fuels and sources of energy; combustion devices and heating elements; instrumentation for temperature and atmosphere control in furnaces; types of furnace construction and design; laboratory analysis of gaseous and liquid fuels; analysis of furnace atmospheres. I, (3). *Prerequisite:* Registration in Met. E. 12 is recommended.

16. Metallurgy of Non-Ferrous Metals.—Processes for the production of aluminum, copper, gold, lead, magnesium, nickel, silver, zinc, and minor non-ferrous metals; problems. II, (3). *Prerequisite:* Met. E. 12.

20. Non-Ferrous Metallography.—Internal structure, constitution, heat treatment, physical and mechanical properties of copper, aluminum, magnesium, lead, and special non-ferrous alloys. I, (3). *Prerequisite:* Met. 10 and 16. Students not majoring in metallurgical engineering may be given permission to take this course without credit in Met. E. 16.

21. Non-Ferrous Metallography Laboratory.—Preparation of metallographic specimens and development of microscopic structures; photomicrography; interpretation of structures developed in non-ferrous alloys. Laboratory to accompany Met. E. 20. I, (2). *Prerequisite:* Registration in Met. E. 20.

22. Electrometallurgy.—Theory and application of the use of electrical energy in metallurgical processes. Laboratory practice in electro-winning, electro-refining, and electro-plating of metals and alloys. I, (3). *Prerequisite:* Met. E. 16.

23. Metallurgy of Deep Drawing and Pressing.—Hot and cold working of metals and alloys; rolling, stamping, forging, drawing, and extrusion of metals and alloys; effects of heat treatment subsequent to working operations. II, (3). *Prerequisite:* Met. E. 13 and 20.

24. Alloy Steels.—Low-alloy high-yield strength constructional steels; elements acting as ferrite strengtheners; elements acting as carbide formers; intermediate alloy steels. II, (3). *Prerequisite:* Met. E. 13 and 14.

25. Physics of Metals.—The physical form of alloys; elastic and plastic properties of single crystals and polycrystalline metals; creep; internal friction; rupture and fatigue; diffusion phenomena; solubility of gases in metals; concepts of

modern physics; electron theory of metals. I, (3). *Prerequisite:* Registration in Met. E. 20 and 21.

26. Advanced Physical Metallurgy Laboratory.—The course is designed to give the student an opportunity to put into practice much of the material learned in previous courses through the solution of individually assigned problems. The laboratory work affords an opportunity to make use of all the equipment in the department. Methods of metallurgical research, use of special laboratory equipment, and solution of industrial problems. II, (3). *Prerequisite:* Senior standing in metallurgical engineering.

30. Engineering Metallurgy.—For students in curricula other than metallurgical engineering. Physical and mechanical properties of metals and alloys as related to their structure and treatment; constitutional diagrams; engineering applications of metals and alloys. I, (3). *Prerequisite:* Chem. 4, 5, or 6; junior standing.

90. Metallurgical Seminar.—Review of current metallurgical literature; classroom reports and discussions; preparation of technical abstracts and reports. I, (1). *Prerequisite:* Senior standing in metallurgical engineering.

91. Metallurgical Seminar.—Continuation of Met. E. 90. II, (1).

97-98. Thesis.—I and II, (1 to 3). *Prerequisite:* High standing and approval of head of department.

99. Inspection Trip.—I, (no credit). *Prerequisite:* Senior standing.

Courses for Graduates

NOTE:—The prerequisite for graduate work with metallurgical engineering as a major is the equivalent of the undergraduate courses required for a bachelor's degree in metallurgical engineering. Courses for advanced undergraduates are open for minor credit to students in other departments who have adequate preparation in physics, chemistry, and mechanics.

101. Research in Metallurgy.—I and II, (*1 to 2 units*). Professor Walker, Assistant Professors Bruckner, Forsyth, Eckel.

102. Advanced Physical Metallurgy.—I, (*1 unit*). Professor Walker.

103. Advanced Alloy Steels and Special Ferrous Alloys.—I and II, (*1 unit*). Assistant Professor Forsyth.

104. Advanced Metallographic Technique.—I, (*1 unit*). Professor Walker.

PHYSICS

Professors: Loomis (Head of the Department), Knipp (*Emeritus*), Watson (*Emeritus*), Kruger, Almy, Kerst, Haworth, Mott-Smith, Bartlett, Goldhaber.

Associate Professors: Schulz (*Emeritus*), Williams, Paton, Dancoff, Lyman.

Assistant Professors: Hanson, Tape, Becker.

Research Assistant Professors: Adams, Koch.

Assistants: Smith, Griffith, Leiter, Phillips, Hatch, Rodgers, Cohn, Zimmerman, Azbell, Heinlein, Driscoll, Sachs, Anderson, Bendel, Bowlden, Buck, Burke, Coburn, Conklin, Drell, Embry, Farber, McDole, McNeil, Mihelich, Moulton, Newell, Saur, Shore, Stump, Taylor, Williams, Wyman.

Introductory Courses for Undergraduates

1a. General Physics (Mechanics, Sound, and Heat).—Lectures with demonstrations and recitations. For students in engineering, mathematics, physics, and chemistry. I and II, (4). *Prerequisite:* Math. 2 and 4; registration in Phys. 3a.

1b. General Physics (Electricity, Magnetism, and Light).—I and II, (4). *Prerequisite:* Phys. 1a; registration in Phys. 3b.

3a. General Physics Laboratory.—To accompany Phys. 1a. I and II, (1). *Prerequisite:* Phys. 1a, or registration therein.

3b. GENERAL PHYSICS LABORATORY.—To accompany Phys. 1b. I and II, (1). *Prerequisite:* Phys. 1b, or registration therein.

7a. GENERAL PHYSICS (Mechanics, Sound, and Heat).—Lectures with demonstrations and recitations. For students in arts and sciences, and architecture. I, (4). *Prerequisite:* Trigonometry; registration in Phys. 8a.

7b. GENERAL PHYSICS (Light, Electricity, and Magnetism).—II, (4). *Prerequisite:* Phys. 7a; registration in Phys. 8b.

8a. GENERAL PHYSICS LABORATORY.—To accompany Phys. 7a. I, (1). *Prerequisite:* Phys. 7a, or registration therein.

8b. GENERAL PHYSICS LABORATORY.—To accompany Phys. 7b. II, (1). *Prerequisite:* Phys. 7b, or registration therein.

10a. MECHANICS, HEAT, SOUND.—Open to all students in the University. I, (4).

10b. ELECTRICITY, MAGNETISM, LIGHT, AND MODERN PHYSICS.—II, (4). *Prerequisite:* Phys. 10a.

Intermediate Courses for Undergraduates

14a. INTERMEDIATE MECHANICS, HEAT, AND SOUND.—For students preparing to teach physics in high schools and for other non-technical students. I, (5). *Prerequisite:* General physics and calculus, or consent of instructor.

14b. INTERMEDIATE ELECTRICITY, MAGNETISM, LIGHT, AND MODERN PHYSICS.—For students preparing to teach physics in high schools and for other non-technical students. II, (5). *Prerequisite:* Phys. 14a.

16. ELEMENTARY HEAT.—I, (3). *Prerequisite:* General physics.

Courses for Advanced Undergraduates

97-98. THESIS.—I and II, (3). *Prerequisite:* Senior standing and approval of head of department.

Courses for Advanced Undergraduates and Graduates

20a. THEORETICAL MECHANICS.—Statics, dynamics of particles. Lectures and problems. I, (3). *Prerequisite:* General physics and calculus.

20b. THEORETICAL MECHANICS (CONTINUED).—Dynamics of rigid bodies; generalized coordinates and LaGrange's equations; vibrations of systems of particles, with electrical analogies. II, (3). *Prerequisite:* Phys. 20a.

23. ELEMENTARY SOUND.—I, (3). *Prerequisite:* General physics.

25. ARCHITECTURAL ACOUSTICS.—II, (2). *Prerequisite:* General physics.

30. INTRODUCTION TO THEORETICAL ELECTRICITY.—Laws of electrostatics, magnetism, electric and magnetic circuits, induced currents, alternating currents, oscillations, and thermionic tubes. Lectures and problems. II, (3). *Prerequisite:* General physics and calculus.

40a. ELECTRICITY AND MAGNETISM.—I, (3). *Prerequisite:* General physics and calculus.

40b. ELECTRICITY AND MAGNETISM.—Ampere's law and applications, motion of charged particles in electric and magnetic fields, electromagnetic induction, alternating current theory, the electromagnetic field. Laboratory experiments in A.C. bridge measurements of capacitance, inductance, vacuum tubes, and magnetism. II, (3). *Prerequisite:* Phys. 40a.

44. ELECTRIC AND MAGNETIC MEASUREMENTS.—Resistances, galvanometers, capacitances, potentiometers, thermocouples, inductances, magnetization, high frequency measurements. I and II, (3). *Prerequisite:* General physics and calculus.

46a. VACUUM TUBES.—I, (3). *Prerequisite:* Phys. 40a-40b, or consent of instructor.

46b. VACUUM TUBES (CONTINUED).—II, (3). *Prerequisite:* Phys. 46a.

50a-50b. BIOPHYSICS.—I and II, (3). *Prerequisite:* Phys. 40a and 40b, or registration in Phys. 40b; Chem. 2 or 3 and 4; Zool. 1 or Bot. 1. It is desirable for the student to have had or to be registered in Chem. 40.

51a-51b. BIOPHYSICS LABORATORY.—I and II, (1). *Prerequisite:* Phys. 50a-50b or registration therein.

60. HEAT AND THERMODYNAMICS.—Heat phenomena, mechanical theory of heat, thermodynamics. Lectures and recitations. I, (3). *Prerequisite:* General physics and calculus.

62. Kinetic Theory of Heat and Radiation.—II, (3). *Prerequisite:* General physics and calculus.

71a. Light.—Geometrical and physical optics; the electromagnetic theory of light. Lectures and recitations. I, (2). *Prerequisite:* General physics and calculus.

71b. Light (Continued).—II, (2). *Prerequisite:* Phys. 71a.

72a. Light Laboratory.—Lenses and prisms, diffraction, interference, polarization. I, (2). *Prerequisite:* Registration in Phys. 71a.

72b. Light Laboratory (Continued).—Spectroscopy and photographic photometry. II, (2). *Prerequisite:* Registration in Phys. 71b.

73. Photography.—II, (3). *Prerequisite:* General physics; consent of instructor.

80. Atomic Physics.—I, (3). *Prerequisite:* General physics and calculus.

81. Radioactivity and Nuclear Physics.—II, (3). *Prerequisite:* Phys. 80.

Courses for Graduates

NOTE:—A year of calculus and a year of general physics, with laboratory, are prerequisite for all major and minor graduate work in physics. In addition, graduate students whose major is physics must have had one more advanced course in either physics or mathematics and should be able to use references in German.

109. Historical Development of Physics.—II, (*1 unit*).

122a-122b. Dynamics.—Continuous through I and II, (*1 unit*).

123. Acoustics.—II, (*1 unit*).

127a-127b. Relativity.—Continuous through I and II, (*1 unit*).

128. Problems and Methods of Theoretical Physics.—II, (*1 unit*).

146a-146b. Electrodynamics.—Continuous through I and II, (*1 unit*).

160. Thermodynamics.—I, (*1 unit*).

163. Statistical Mechanics.—I, (*1 unit*).

170a-170b. Advanced Physical Optics.—Continuous through I and II, (*1 unit*).

181a-181b. Quantum Mechanics.—Continuous through I and II, (*1 unit*).

182. Conduction of Electricity through Gases.—I, (*1 unit*).

183a-183b. Nuclear Physics.—Continuous through I and II, (*1 unit*).

184. Line Spectra and Atomic Structure.—I, (*1 unit*).

185. Band Spectra and Molecular Structure.—II, (*1 unit*).

186a-186b. Advanced Quantum Mechanics.—Continuous through I and II, (*1 unit*).

190. Research.—I and II, (*1 to 3 units*).

191a-191b. Modern Laboratory Practice.—Continuous through I and II, (*1 unit*).

198. Seminar.—I and II, (*1 to 2 units*).

199. Physics Colloquium.—Weekly meetings of instructors and advanced students for the presentation and discussion of papers on current problems. Attendance expected of all graduate students. I and II, (*no credit*).

THEORETICAL AND APPLIED MECHANICS

Professors: Seely (Head of the Department), Moore (*Emeritus*), Enger, Richart, Putnam, Draffin, Schrader, Dolan, Ensign, Schwalbe.
Associate Professors: Lansford, Collins.
Assistant Professors: Findley, Black, Jones, Smith.
Associates: Brown.
Instructors: Worley.
Cooperating: Professor N. M. Newmark.

Courses for Undergraduates

1. Analytical Mechanics (Statics).—Force systems, equilibrium, centroids, center of gravity, friction. I and II, (2). *Prerequisite:* Math. 7; registration in Math. 9.

2. Analytical Mechanics (Dynamics).—Kinematics and kinetics. I and II, (3). *Prerequisite:* T.A.M. 1.

3. Resistance of Materials.—Mechanics of materials, properties and requirements for materials of construction. I and II, (3). *Prerequisite:* T.A.M. 1.

4. Hydraulics.—Pressure and flow of water, utilization as motive power. I and II, (2). *Prerequisite:* T.A.M. 1; registration in T.A.M. 2.

5. Mechanics of Fluids.—Kinematics of fluid motion; elements of hydrodynamics; effects of viscosity, compressibility, and drag. II, (3). *Prerequisite:* T.A.M. 2.

17-18. Elements of Mechanics (Statics) and Strength of Materials.—Force systems; equilibrium; friction, centroids; direct stress, riveted joints, beams, moment of inertia, deflection, columns. For architects and others who have not taken the calculus. Continuous through I and II, (3). *Prerequisite:* Math. 6a.

63. Resistance of Materials Laboratory.—Tests to determine the properties of materials and their significance in engineering construction. I and II, (1). *Prerequisite:* Registration in T.A.M. 3.

64. Hydraulics Laboratory.—Measurements of flow, friction in pipes, pumping and power. I and II, (1). *Prerequisite:* Registration in T.A.M. 4.

Courses for Advanced Undergraduates and Graduates

41. Advanced Mechanics of Materials.—Special problems met in engineering. I, (3). *Prerequisite:* T.A.M. 3 and 63.

42. Properties of Engineering Materials: Specifications and Inspection.—Properties and uses of materials of construction. Standard specifications for materials. II, (3). *Prerequisite:* T.A.M. 3 and 63.

43. Laboratory Work in Hydraulics.—Measurement of water, pumps, water hammer; special problems. I and II, (3). *Prerequisite:* T.A.M. 4 or 5.

44. Laboratory Work in Testing Materials.—Testing machines and strain measuring apparatus; practice in making standard tests in tension, compression, and flexure. I and II, (3). *Prerequisite:* T.A.M. 3 and 63.

47. Engineering Analysis.—Methods of analysis in engineering mechanics, including the mathematical, model analogy, graphical, dimensional, statistical, and various approximate methods. I, (3). *Prerequisite:* T.A.M. 2 and 3.

48. Engineering Analysis.—Continuation of 47. II, (3).

49. Advanced Dynamics and Vibrations.—Free, forced and damped vibrations of structures and machines, resonances, self-induced vibrations. I, (3). *Prerequisite:* T.A.M. 2 and 3.

50. Advanced Dynamics and Vibrations.—Continuation of 49. II, (3).

Courses for Graduates

NOTE:—Graduate students electing theoretical and applied mechanics as their major must have had the equivalent of the undergraduate courses required for a bachelor's degree in general engineering. The courses open to seniors (as listed above) may be taken for minor credit by graduate students whose major is in other departments.

101. Mechanics.—Development of basic ideas. I and II, (*1 unit*).

103. Fluid Mechanics.—I and II, (*1 unit*).

107. Laboratory Investigations in Strength of Materials.—I and II, (*1 to 2 units*). Professor Dolan, Associate Professor Collins, Assistant Professors Findley, Jones, Smith.

108. Laboratory Investigations in Hydraulics.—I and II, (*1 to 2 units*). Associate Professor Lansford.

109. Laboratory Investigations in Plain and Reinforced Concrete.—I and II, (*1 to 2 units*). Professor Richart.

110. Analytical Study of Experimental Work on Reinforced Concrete.—Beams, frames, and footings. I, (*1 unit*). Professor Richart.

111. Analytical Study of Experimental Work on Reinforced Concrete.—Columns and slabs. II, (*1 unit*). Professor Richart.

112. Structural Mechanics.—Survey of methods of determining deformations and stresses in built-up structures, especially statically indeterminate structures. I, (*1 unit*). Professor Schwalbe.

113. Selected Topics in Structural Mechanics.—II, (*½ unit*). Professor Schwalbe.

114. Theory of Elasticity with Applications to Engineering Problems.—I, (*1 unit*). Professor Newmark.

115. Theory of Elasticity with Applications to Engineering Problems.—Continuation of 114. II, (*1 unit*). Professor Newmark.

116. Resistance of Materials.—I, (*1 unit*). Professor Seely, Assistant Professor Smith.

117. Properties of Engineering Materials.—II, (*1 unit*). Associate Professor Collins.

198. Thesis.—I and II, (*1 to 2 units*). Members of the department.

GRADUATE WORK AND RESEARCH

AS ENGINEERING SCIENCE AND PRACTICE develop and expand in multitudinous ways, it becomes increasingly evident that the standard four-year curricula do not provide time for more than a thorough education in the underlying physical and mathematical sciences and a moderate amount of application of these sciences to problems of design, construction, and operation, together with a substantial groundwork in language, social sciences, and some of the arts. There is little opportunity in the four-year program for really advanced work in engineering science. Therefore, the College of Engineering encourages graduates of high scholastic interest and achievement to continue their training into the graduate field for at least one year, or until they have earned the master's degree, in the belief that graduate work pays liberally by every standard of appraisal.

Each department of the college, except Aeronautical Engineering, General Engineering, and General Engineering Drawing, is provided with adequate facilities and a competent staff to conduct graduate work in almost all phases of its field of engineering interest. The staff members who supervise graduate work are also considered as members of the Graduate School Faculty. Students register in the Graduate School, and on its certification degrees are conferred.

Testing Car Wheels for Effect of Heating under the Application of Brakes

Admission to full graduate status in engineering presupposes the completion of a four-year curriculum of study in the field in which the student proposes to do graduate work, either at the University of Illinois or at some other accredited institution in a substantially equivalent curriculum. Students who do not meet these requirements in full, and who are not candidates for a master's degree, may be admitted to graduate study in courses for which they have special preparation. Full particulars concerning graduate work and advanced degrees, including professional degrees in engineering, are given in the *Graduate School Announcement,* which may be obtained by addressing the Dean of the Graduate School, 109 Administration Building, Urbana, Illinois.

Graduate work in engineering is very often associated with the research programs of the Engineering Experiment Station, both in connection with the investigations sponsored by cooperating agencies in industry and with investigations maintained solely by the College of Engineering itself. This relationship furnishes a valuable opportunity for the exercise of individual and creative ability, in addition to bringing the young investigator into close personal contact with a corps of research men of wide experience.

The facilities for large-scale, wide-range investigations are exceptional. Typical of the equipment for such purposes are the 3,000,000-pound Emery-Tatnall testing machine; the cyclotron and betatrons (with a 250-million-volt betatron to be erected in 1946); the newest equipment available for research in electronics; up-to-date research facilities in the aerodynamics laboratory and at the University of Illinois Airport; the warm air heating research residence, the steam and water research home; the steam and electric railway test cars; the high-pressure gas building; and the laboratories for handling and testing large specimens. Research is also conducted at various places in the country on industrial equipment and structures under actual operating conditions. This kind of research is typified in the test work on railway track.

The results of investigations carried on in the ways outlined are published in the form of theses, articles in the technical press, and in bulletins of the Engineering Experiment Station, thus making these findings widely available to industry and the public.

The University normally maintains fourteen research graduate assistantships in the Station. In addition, several other assistantships are usually maintained by industrial organizations, the number varying from year to year. These assistantships are open to graduates of approved universities and technical schools who are prepared to undertake graduate study in engineering, physics, or applied chemistry. These assistantships carry a nominal stipend and exemption from tuition fees in courses that count for graduate credit. Appointment must be accepted for two consecutive collegiate years, at the expiration of which, if all requirements have been met, the degree of Master of Science is conferred. Not more than half of the time of these assistants during ten months of each year is required in connection with the work of the department to which they are assigned; the remainder of their time is available for graduate study. Further details concerning the research graduate assistantships may be obtained by addressing the Director of the Engineering Experiment Station, 106 Engineering Hall, Urbana, Illinois.

The Station has published 364 bulletins, 51 circulars, and 33 reprints. All these publications are regarded as contributions to the literature of engineering, and many of them present important additions to the science of engineering.

GENERAL INFORMATION FOR STUDENTS

THE EDUCATIONAL AND SOCIAL PROGRESS and development of students in the College of Engineering are promoted in many ways. On the campus of a large university in which are enrolled both graduate and undergraduate students of wide educational and professional interests, the opportunities for self-development of the engineering student outside the classroom and laboratory are greatly enhanced. Though it is impossible in this publication to describe all the matters of interest to a prospective student, some of the more important phases of college life at the University of Illinois are presented in the following paragraphs.

Student Housing

Living conditions of students in Urbana-Champaign are supervised by the University's Director of Student Housing, who is responsible for standards of health, safety, comfort, study conditions, social facilities, and reasonableness of charge. All residence halls, fraternity and sorority houses, cooperative houses, and privately operated student homes are subject to periodic inspection and official approval. Unmarried undergraduate students not residing with their parents, guardians, or relatives are required to live in places approved by the University. Personal assistance is given to individual students in their housing problems.

The organized houses include 56 fraternities and 21 sororities, in which membership is by invitation, and numerous privately operated houses in the Men's Independent Ward Association and the Women's Group System. In most of these organized houses the accommodations include meals. Some are cooperatives, in which the students share the work and expense. Many other houses, with rooms for smaller numbers of students, are approved, some for men and some for women. Every housing unit is under the direction of a responsible individual, approved by the Director of Student Housing and by the Dean of Men or the Dean of Women.

Special provisions for student housing were arranged during 1946 in an effort to accommodate the rapidly increasing enrollment following World War II. In addition to two women's residence halls and two residence halls for men, returned to civilian use after their war-time accommodation of Navy and Army units, hundreds of prefabricated houses were erected for married veterans and their families, and temporary dormitories for veterans were constructed on the Urbana campus. In addition, a long-range plan for the erection of further permanent dormitories, both for men and for women, was announced. All housing units allotted to veterans are assigned on a carefully worked-out basis of war service, previous University attendance, and other pertinent factors.

Requests for information concerning accommodations may be addressed to the Division of Student Housing, 108 Illini Hall, Champaign, Illinois.

The Illini Union

This office provides current lists of approved student homes, rental contract forms, and other information concerning room and board.

Illini Union

The Illini Union is the social, cultural, and recreational center for all students in Urbana-Champaign. It is operated, not for profit, but for the benefit of students, faculty, alumni, and friends of the University. Among its many facilities are various food service units, consisting of a cafeteria, soda fountain, large dining room, and several smaller dining rooms. The cafeteria serves special menus at set prices and thus enables students to budget their board. The several lounges are meeting places for students and faculty between classes and in other free times. The browsing room, a branch of the University Library, contains the latest fiction, biography, and other books for general reading. In the General Lounge there are daily programs of recorded music arranged by a student-faculty committee. The recreational facilities include bowling alleys, pool and billiard tables, and rooms for other games. Weekly dances are held in the ballroom. All students pay $5.00 each semester which entitles them to full use of the building.

Annual Expenses

The annual expenses of students vary, of course, with individual tastes and standards of living. They are somewhat greater in the engineering curricula than in some of the other curricula of the University, because of the larger amount of laboratory work involved and the need for drawing equipment, slide rule, handbooks, and other supplies. The costs of supplies also vary according to the curriculum chosen in engineering. Minimum and moderate annual budgets (as of July, 1946) for an engineering student, exclusive of such variable items as clothing, railroad fare, and recreation, are tabulated below. This estimate covers two semesters for students who are residents of Illinois. (For those who are not residents of Illinois the tuition is higher.)

Estimated Annual Expense Budget

	Minimum Budget	*Moderate Budget*
Matriculation fee (new students only)	$10	$10
Tuition fees (residents of Illinois)	80	80
Laboratory, library, and supply fee	10	10
Hospital and medical service fee	10	10
Illini Union service charge	10	10
Textbooks	25	30
School supplies	14	18
Room	100	130
Board	250	325
Laundry (mailed home)	9	9
Miscellaneous	20	90
	$538	$722

NOTE:—Each student at Urbana must make a deposit of $5. An additional deposit of $10 ($15 in all) is required of students withdrawing military equipment.

Fees.—The fees for each semester are due and payable at the time of registration. The amount of fees is not the same for all semesters, nor for all students. Freshmen, for example, must pay certain costs not required of upperclassmen, and not included in the above table of minimum expense.

Each student entering the University as a candidate for a degree pays a *matriculation* fee of $10; and when he has completed the requirements for the degree, he pays a *graduation* fee of $10. If, after graduation, the student continues his work as a candidate for another degree, he does not pay the matriculation fee again, but the graduation fee is assessed for each degree conferred.

The tuition fee is $40 a semester, making $80 a year, for students who are residents of the State of Illinois. It is higher for students who are not residents of Illinois, being $80 a semester, or $160 a year. (Out-of-state students should also allow for other modifications in the accompanying table of expenses, according to the distance of their homes from Urbana.) The eligibility of a student to register as a resident of the State of Illinois is determined by the Registrar of the University.

The *laboratory, library, and supply* fee covers the cost of materials provided by the University for use by students and the cost of such special services as are chargeable to a particular course.

An *unclassified student,* that is, one who is not a candidate for a degree and who is not matriculated, pays each semester a fee of $7.50 in addition to the regular tuition fee stated above.

Special Provisions for Veterans

In view of the complex problems of training and purpose of returning veterans, an agency known as the Division of Special Services for War Veterans has been established to aid them. Men and women coming from the armed forces may make their first contacts with the University through this agency. The facilities of the Division give the returning veteran every opportunity to adjust himself quickly and effectively to university work and to insure that he will receive the utmost benefit from it.

The University grants credit for service and for education in the armed forces. Veterans may be eligible for both State and Federal scholarships. Under State benefits, tuition and matriculation fees are waived for the returning serviceman who was either a resident of the State of Illinois or a student at the University of Illinois at the time of enlistment. Qualified veterans may also enter the University under the provisions of P.L. 346 (G.I. Bill of Rights). The University has a contract with the Veterans' Administration through which tuition fees, books, and supplies are provided for vocational training of the injured veteran, and, in addition, an allowance for maintenance is paid. Either servicemen or civilians who are physically disabled qualify for aid from the State vocational rehabilitation program which covers all college expense and, in some cases, board and room.

Student Health

The University maintains a Health Service for students to promote their physical and mental health, to control communicable disease among them, and to teach them the essentials of healthful living. Members of its staff give instruction in hygiene, conduct physical examinations, supervise food handlers, make sanitary inspections, hold personal conferences with students, and assist them in every way possible in making prompt adjustment. They strive to reveal to the students the benefits to be derived from sanitation, preventive medicine, and hospitalization. As the functions of the Health Service are primarily educational and preventive, its staff does not assume responsibility for the care of students beyond giving medical advice, administering emergency treatment, and referring students to competent specialists and practitioners of medicine.

McKinley Hospital.—The McKinley Memorial Hospital, a well-equipped, modern establishment with a normal capacity of 112 beds, is particularly designed for student and faculty use. It provides for the care of communicable disease, general illness, emergency surgery, and treatment. It is unusually well equipped with X-ray equipment and other modern devices for the diagnosis and treatment of disease.

Hospitalization and Medical Service.—A hospitalization and medical service fee is charged each student to provide ward care and a substantial payment toward the charges of the attending physician in the event of student illness. In cases of minor illnesses, the payment is sufficient to give the student complete protection. There is also an allowance for laboratory fees, special medicines, and X-ray examinations. This fee is a development of the former Mutual Benefit Hospital Association, which was founded in 1899 and was the oldest organization of its type in existence. The whole plan is arranged to give the greatest benefits to the student who is ill away from home.

Student Employment

An employment service is maintained by the office of the Dean of Men to advise and aid worthy students who desire part-time employment while in the University. This service affords a central clearing point for the employment of all students at Urbana-Champaign, except that women desiring room-and-board jobs are referred to the Dean of Women.

Students are advised not to attempt entire self-support. A student who plans to be partly self-supporting should have a thorough understanding of the financial obligations of a college course, and should have a reserve fund of at least $250 on entering the University. Assignments of work are made on the basis of the actual needs of the students, of their ability to meet the requirements of employers, and of their academic records. The employment service cannot guarantee that work will be found for all needy applicants, although every effort is made to find opportunities for all. No charge is made for this service.

An applicant for work should appear in person at the employment office, 104 Administration Building (East), on or before the regular days for registration. As jobs are not assigned in order of date of application, there is no need for prospective students to make special trips to the campus far in advance.

Scholarships and Loan Funds

A number of undergraduate scholarships have been provided for worthy students who are in need of financial aid. The scholarships available to new students exempt their holders from the payment of the matriculation fee ($10) and the tuition fee ($40 each semester), but not laboratory fees. Engineering students are eligible to receive the following scholarships under regulations fixed by the University and administered by the Registrar: County Scholarships, awarded through competitive examinations, one for each county in Illinois; General Assembly Scholarships, awarded on nomination by members of the State Legislature; and a number of others. Further information concerning scholarships will be furnished by the Registrar of the University.

The University has several funds from which loans may be made to worthy needy students. Except for small short-term loans to meet emergencies, these funds are used to finance students of good scholastic achievement who have been in the University long enough to indicate with a fair degree of certainty that they will finish the work required for graduation. The loans are repaid after graduation at reasonable rates of interest. Freshmen are not ordinarily eligible for loans.

Prizes and Awards

Engineering students are eligible to compete for many University prizes of varying amounts and character. In addition, numerous prizes and awards restricted to engineering students have been made available through the generosity of individuals and of engineering organizations. Information concerning them may be obtained from the Dean of the College of Engineering.

Honors and Honorary Societies

Students in engineering are graduated with honors or high honors on the basis of exceptional scholastic achievement in certain specified courses, totaling about forty semester hours, in the junior and senior years of each curriculum, and superior accomplishment in all other work of the curriculum. University recognition of high scholastic standing is also given in the Honors Day Convocation in which engineering students of all classes are included in numbers proportional to their registration in the University. College recognition of the achievements of engineering students is given in several ways, chiefly through the honorary organizations of *Tau Beta Pi* and *Sigma Tau*. There is also, in each department, an organization with national affiliations that marks the outstanding students of the group in a fitting manner. Prominent among these are *Keramos* in Ceramic Engineering, *Chi Epsilon* and *Mu San* in Civil Engineering, *Eta Kappa Nu* in Electrical Engineering, and *Pi Tau Sigma* in Mechanical Engineering. Prizes and awards are made to outstanding students by many of these organizations. In addition, engineering students are eligible to election to honor societies of an all-university character.

Student Organizations and Activities

In the belief that extracurricular activities are potent factors in the development of the well-trained engineer, the College of Engineering fosters numerous organizations and enterprises which furnish opportunity to the students to employ their time and energies in desirable ways outside the strictly academic requirements of their curricula. Among the three hundred or more associations, societies, and clubs on the University campus, offering opportunity for the development and expression of varied interests and talents, there are seven student organizations of a professional character in the College of Engineering, one in each degree-granting department, which are affiliated with national societies as branches or chapters of the parent organization. These societies are managed entirely by the students and furnish an effective means for promoting the professional development of the young engineer. Prominent practicing engineers appear on the programs of these societies at regular intervals. Activities that are all-college in character are sponsored by the societies, acting through a council made up of officers of these organizations. Unique among the student activities are the Electrical Show and the Engineering Open House which are given in alternate years by the students. The success of these enterprises is indicated by the considerable size of the student loan fund built up from the proceeds of the Electrical Show during the twenty or more years of its existence.

Another important activity of engineering students is the *Illinois Technograph,* a publication issued monthly during the scholastic year. Written, edited, and published by students in the College of Engineering, the *Technograph* has been in existence for 25 years and, as a member of Engineering College Magazines Associated, compares favorably with other engineering magazines issued by leading universities.

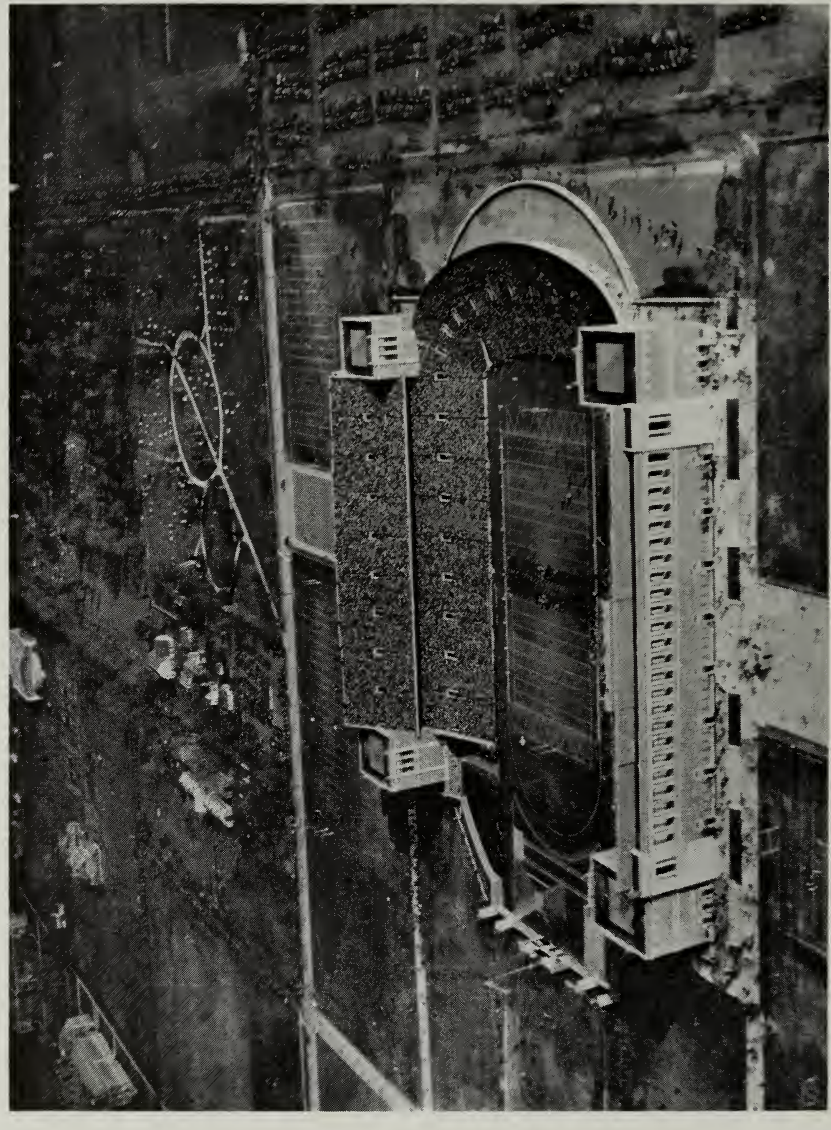
Engineering students are encouraged to participate in student activities, thus developing a side of their personal training that cannot be accomplished so readily in the classroom and laboratory. Few of the many activities on the campus lack engineering students on their boards of direction or in their working personnel.

Physical Education and Athletics

An extensive and well-rounded program of physical development for both men and women is carried on by the University. The equipment and playgrounds are modern and adequate. Physical education courses are required of men students during the first two years. Supplementing the formal curricular requirements in physical education is a program of voluntary intramural sports, competitions, and exhibitions, sponsored by the School of Physical Education. These activities are widely participated in by students of all classes. Intercollegiate athletics form a fitting climax to the University's program of physical education and sports activities. Even though comparatively small numbers of students are able to engage in intercollegiate competition, these sports are held in high esteem by the student body generally, and they undoubtedly inculcate a lively spirit of honest effort and fair play in the hearts of thousands of young men and women who witness the games each year.

Military Training

All male students who are citizens of the United States and physically fit, except students over twenty-two years of age when entering the University, students entering the University with junior standing, students who have had two years military training in other senior units of the Reserve Officers Training Corps or equivalent training in junior units of the ROTC, students holding commissions in the Officers Reserve Corps of the Army,



University of Illinois Memorial Stadium

Navy or Marine Corps, or students who have had one year of active service, must register in Military Science and Tactics, or Naval Science, and unless properly excused, must take the full basic course therein, whether they intend to graduate or not. The University Brigade consists of the following units of the ROTC: Infantry, Cavalry, and Engineers. It is tentatively planned to activate the following units in the fall of 1946: Field Artillery, Signal Corps, Air Corps, Ordnance, Quartermaster Corps, Armored Force, Transportation Corps, and Veterinary Corps. A student is normally free to choose any branch for which his aptitude and course of study fit him. However, the Signal Corps is reserved for electrical engineers specifically, and the Engineer Corps is elected by all other engineers with few exceptions. The basic course of two years of work is a general prerequisite for graduation. The final two years of work, which are optional, are called the advanced course, and students in the advanced course serve as the officers of the brigade; completion of the advanced course qualifies the candidate for a commission in the organized reserves of the United States Army. Those students registered in the Naval Reserve Officers Training Corps will be given similar thorough training programs.

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